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The Kane-Pennington Motor.

BY JOHN RANDOL.

During my first inspection of the Kane-Pennington motor, I thought I was not treated with the entire frankness due to an impartial observer, if he be allowed to observe a strange and wonderful thing. I saw a heat engine, for I suppose the explosion engines are as rightfully to be called heat engines as if they took heat slowly and through the comparatively moderate and leisurely process of ordinary burning, instead of employing pressures established by the sudden and violent deflagration of some explosive compound. I saw, I say, a heat engine of such exquisite simplicity that a child might easily remember all of its few parts and their uses, and all so small and light that a child might use them for playthings; a machine so absurdly lacking in all the parts and appliances which I had been trained by example and theory to believe essential to the effectiveness of motors of its class, that if previous knowledge were not wholly error, this new wonder should not be able to even move itself; yet this incredible machine not only did move itself, but moved with such vigor of action as to drive loads far beyond its apparent possibilities. I expressed my surprise and admiration and my eager desire for information, and in response Mr. Pennington gave me a halting, and, as it seemed to me, a ridiculously impossible theory of the method by which the enormous proportion of heat which the ordinary gas engine wastes on the water jacket is in the Kane-Pennington motor converted into work, and at the end of that first examination of the motor I wrote what follows. Further consideration made me dissatisfied with what I had written, and I went back to the Kane-Pennington shops, and was shown everything which the place contains, and permitted to satisfy myself fully as to the function and working of all parts of the motor. I found that I had been told the exact truth so far as the actual and observable facts were concerned, and, that is, that in some way, so far wholly unexplained, the great heat which in other explosive engines manifests itself as an inconvenient by-product to be taken care of as best it may, is in the Pennington engine transformed into useful effect on the piston. I know that when the long, thin, first spark is not put through the charge the engine becomes weak and hot, and that when this first long, thin spark, this "mingling" or "ripening" spark, as Mr. Pennington calls it, is used, a common gas engine with its carburetter eliminated gives twice its ordinary effect on the crank. I know also that all the experts who have been employed by capitalists to examine this engine have been first incredulous and then amazed, and finally enthusiastic, and I have therefore decided to let this first paper stand as it is, because it correctly exhibits not only my own experience, but the experience of all others both learned and simple, upon a first examination of the motor.

All of the indicator cards and all data and records in possession of the Kane-Pennington establishment were offered to me, but as some of them cannot at present be put before the public I did not choose to take them away with me, or even to examine them, as I prefer not to become the repository of avoidable secrets. I shall very soon, however, describe in the minutest detail the two-spark mechanism of the Pennington motor which actually does not cost five cents, and yet when applied to the "Regan" gas engine, largely built up to the present time by the Kane establishment at Racine, doubles the power of that motor. It is in the igniter, and in the double spark, or rather in the effect of the first spark, apparently, that the efficiency of the Pennington motor lies. This statement is as incredible to my mind now as it was when I first heard it from the lips of Mr. Pennington, but this first spark seems to be the only possible agency through which this motor achieves its miraculous results, and gives us a heat engine which delivers in usable work a great part of the possible effect of the heat delivered to it, and so opens a new round of dazzling possibilities to the engineer.

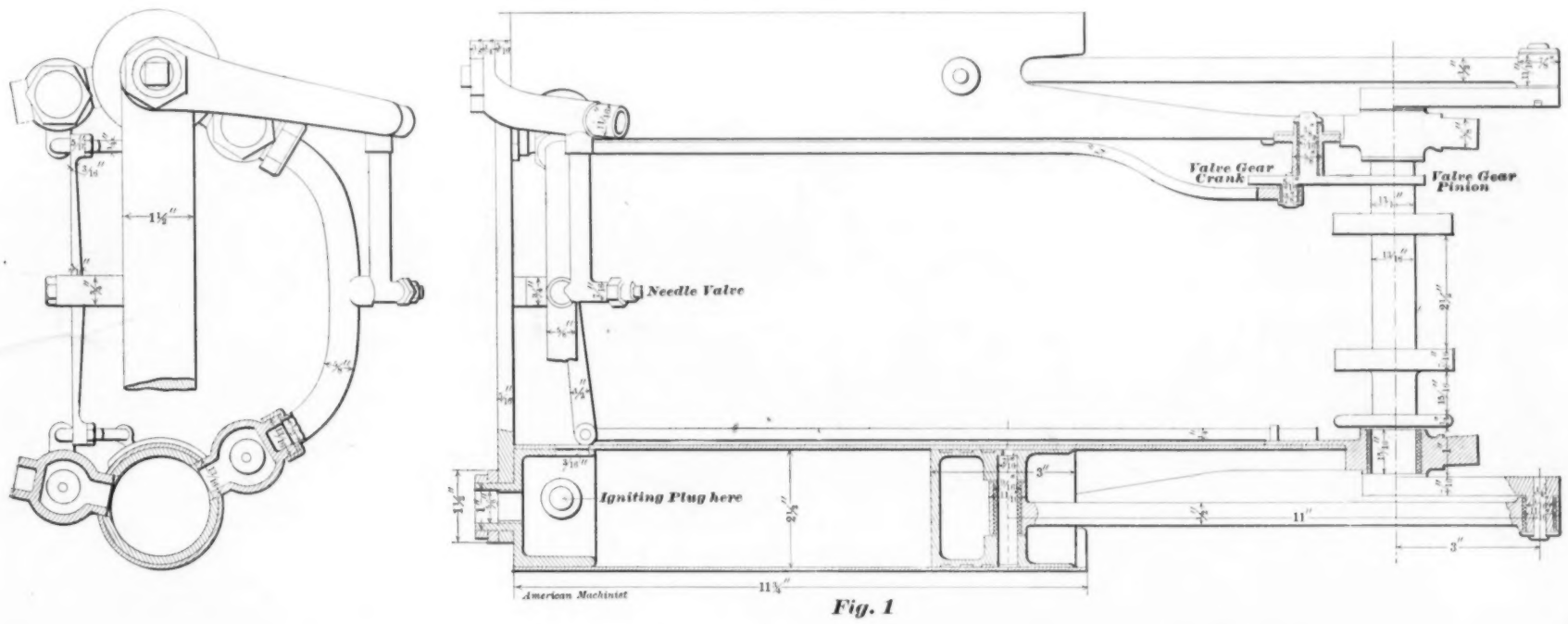


Fig. 1

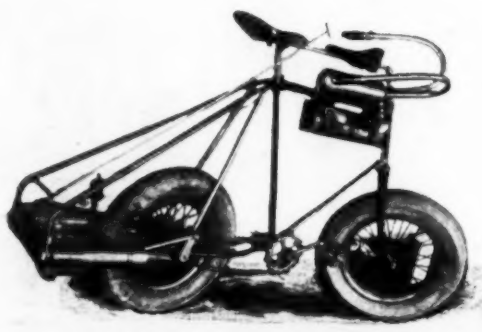


Fig. 2.

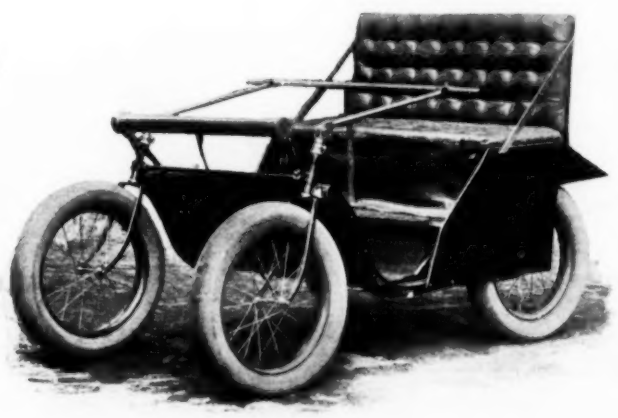


Fig. 3.

THE KANE-PENNINGTON MOTOR.

Fig. 4.

One thing is certain, however, the Kane-Pennington motor, the general working drawing of which is now given (for the first time in any printed publication) in Fig. 1, is less than 17½ pounds heavier than the final 4½ I. H. P. motor, because the Kane-Pennington develops 4.75 I. H. P. at its regular speed of 700 turns, and weighs only 17½ pounds all told. It is quite unreasonable to suppose that motors will ever be produced which have no weight whatever, hence it is surely safe to say that "Air Ship" Penn-

ington, out of the clouds and on the ground, is within less than 17¼ pounds avoirdupois of the ultimate results of human effort in the production of 4¼ H. P. motors.

No fire, no water, no boiler, no carburetter—only a few pieces of steel with a few brass-bushed joints, a battery weighing one pound, and a gallon of kerosene, put these with a bicycle, bringing the weight of the whole piece of wizardry up to 58 pounds, and a man may be carried by it on a smooth road a mile in 58 seconds, as a man was carried

To run a mile a minute with 22-inch diameter wheels requires over 900 turns; it is therefore certain, as cycle, Fig. 2, did run a mile in 58 seconds, that the motor can make about 920 turns per minute. I was one of the riders on a Pennington tandem, Fig. 7, weighing 106 pounds, over a poor block pavement, railway tracks, etc., with wheels and engine like those shown in Fig. 2; the time was not taken; it was quite sufficiently swift, however, to satisfy all my longings for speed.

gers, Pennington himself in the middle, and in Fig. 5 from the rear, with the machinery exposed, can make 20 to 25 miles easily, and more if pushed on a common (dirt) road. As will be seen from Fig. 5, the motive power is the same as shown in Fig. 1, chain geared with two reductions, first to an intermediate shaft, then to a variable speed shaft, and last, from the variable speed shaft back to the drivers, each wheel being independently driven, as there is no through shaft for either the rear or front wheels, the "Victoria" de-

sprocket wheel is loose and may be clutched to the shaft by moving the upright lever seen rising from the footboard in Fig. 3. When not clutched to the shaft the engines run without moving the vehicle; to start the engines, one complete turn of the engine shaft is made by hand, and it then continues to run from the action of the engines until either the oil or the spark-producing current is shut off. After the one revolution by hand the riders mount the seat, and a movement of the vertical lever clutches the sprocket to the variable speed intermediate shaft and the "Victoria" at once begins to move.

Mr. Pennington informed me that he would not be a competitor in the *Times-Herald*, Milwaukee-Chicago, $5,000 prize race, as he preferred some of his customers should take the money, it being the intention of the Kane-Pennington concern to supply motors only, not complete self-driven vehicles, to the public. It is quite probable that several entries in the Milwaukee-Chicago race will be driven by Kane-Pennington motors, as the leading cycle makers have ordered motors of this type.

Fig. 6 shows a more powerful vehicle in course of construction, equipped with two pairs of engines, instead of the one pair, as in the "Victoria," and Fig. 8 gives a clear idea of the 2-cylinder motor on a wrought-steel angle, latticed frame, same as used in the "Victoria." The total weight of the "Victoria" unloaded is less than 400 pounds.

Fig. 7.

Fig. 5

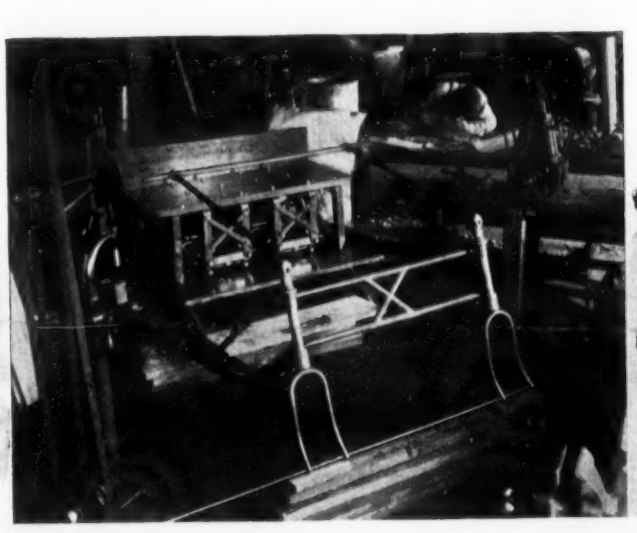


Fig. 6.

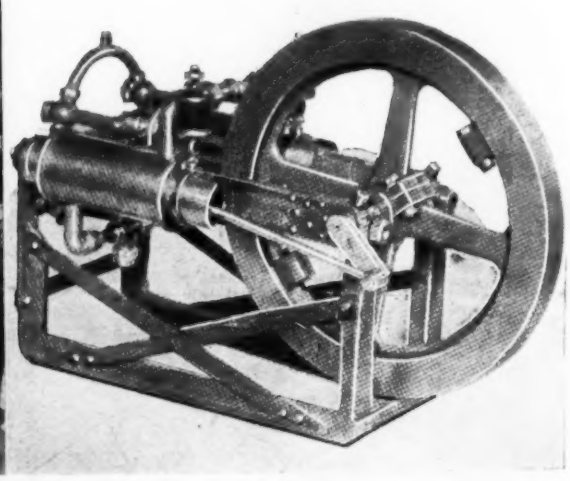


Fig. 8.

Fig. 9.

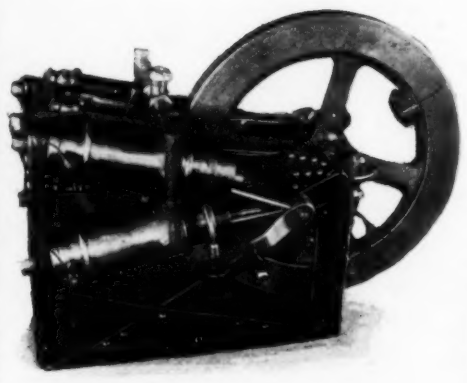


Fig. 10.

Fig. 11.

THE KANE-PENNINGTON MOTOR.

on one of the asphalt paved streets in the city of Milwaukee a few days since.

The machine which made this run of a straightaway mile in 58 seconds is shown in Fig. 2. To avoid the weight of reducing gear the diameter of the cycle wheels is dropped to 22 inches, and to give adhesion and avoid puncture the pneumatic tires are made 4 inches diameter, after Pennington's specifications, and cannot be injured by a hammer and nail in skilled hands; the attempt to drive the nail into the inflated tire results in a simple rebound of the nail, the tire remaining intact.

My sensations were much less piquant during a ride in company with Mr. Pennington in the "Victoria" shown in Fig. 3. This machine was built in 1894, and is driven by such a pair of engines as are shown in Fig. 1. This ride was made in the yard of the extensive works of the Racine Hardware Co., and the round, owing to the recent rains, included several spots of very soft mud, but as might be expected from the location of the weight, almost wholly over the driven rear wheels, there was no slip of the drivers. This "Victoria," shown in Fig. 3 empty, in Fig. 4 with three passen-

sign being on strictly bicycle construction lines. The reduction from the engines to the driving wheels is 4 to 1 for the slow speed and 2 to 1 for the quick speed; the upright hand lever mentioned below has three positions; standing upright the engines are disconnected from the driving wheels; hand lever to right gives 4 to 1 reduction to drivers; moving hand lever to left gives the quick drive, which is a 2 to 1 reduction from the motors to the drivers.

The "Victoria" engines have a fly-wheel, and the right-hand crank wrist is prolonged to form a handle; the intermediate shaft

The weight of an ordinary road wagon or "buggy" is about the same. The consumption of common kerosene oil per hour per horse-power indicated is about one-tenth of one gallon, or about 2 quarts per hour for 4.75 H P. It is quite needless to say that nothing approaching the weight and power given has ever been shown by any motor within the general knowledge of the public. The common one horse-power gas engine, for instance, has a piston weighing, say, 60 pounds; the Kane-Pennington has a piston shown in Fig. 1, 2¼ inches diameter by 3 inches long, which weighs about ⅛ of a

pound. The best speed for a common 1 H. P. gas engine is 200 to 250 turns, while the Kane-Pennington can maintain a speed of 2,000 revolutions, without danger or difficulty, and at this speed a nominal 1 H. P. motor will develop over 10 horse-power. The common gas engine cylinder will rise far beyond the safe limit of temperature, if not artificially cooled; the Kane-Pennington can be run without inconvenience without water jacketing, and Mr. Pennington said to me that they not only could be run without water, but gave better results in every way without the water jacket.

Should the gas engine and locomotive engineer who visits Mr. Pennington not be sufficiently disorganized in all his thoroughly sound views and old-established laboratory-test and scientific-experiment-determined formulæ when he reaches the end of the foregoing surprises, he can ask Mr. Air Ship Pennington to show him the March hare fantasy exhibited in Fig. 9, where a bicycle of commercial pattern is equipped with one of the same one-horse motors, which scorns dull earth and lays hold of the air itself through a steel frame, enameled cloth-covered screw, 36 inches diameter; two blades, steel wire braced corner to corner, weight, 6½ pounds; greatest width of blade, 14 inches, and angle at circumference, 17 degrees. This makes a total weight of 58 pounds of self-propelling locomotive-driven by a heat engine, which will carry a 200-pound man on a common road 35 miles or more per hour. The engine shown in Fig. 11 is used without a fly wheel, seven to twelve hundred turns per minute. Mr. Pennington may also exhibit to his interviewer another four-blade propeller with a wooden frame, also enameled cloth covered, and weighing only 6½ pounds, although it is 42 inches, and has blades 20 inches wide at circumference of screw, still the same 17-degree angle, which can drive the "Victoria" at the same speed which the chain gear and driving wheels produce.

The screw cycle, Fig. 9, was lashed into a 21-foot clinker-built boat, 3½ feet beam, with 3 men and 600 pounds of stone ballast, and made 8 to 9 miles per hour in Racine River, September, 1895, under this air-screw propulsion.

After I had, for that occasion at least, escaped sudden death by alighting from the demon-driven tandem, and had become quite satisfied that my entire anatomy was still serviceably intact, I felt of the water jackets of the cylinders and found them barely blood warm. I had noticed that the tank of cooling water was absurdly small, and had expected to see steam coming from it long before. I asked Mr. Pennington how this coolness could be, and he replied that all fluids took up vast amounts of heat in the change to vapor, and that as his engine used no carburetter, but vaporized the charge directly in the cylinder, the fluid in vaporizing absorbed the heat the cylinder walls had derived from the last explosion, and hence kept the heat of the cylinders at a comparatively very low point.

Mr. Pennington went on to say, first, that the charge was exploded only when the effective stroke crank angle was 45 degrees, and that previous to the delivery of the igniting spark to the charge there was a "mingling" current of electricity put through the air and gas in the cylinder, and that by virtue of this non-igniting current delivered to the mixture the heat absorption power or capacity, one or both, of the gas in the cylinder was so incredibly augmented that the cylinder temperature could be, and actually was, so greatly lowered that the walls of the cylinder were kept cool to within convenient working limits. Perhaps it was a look of surprise that led Mr. Pennington to feelingly remark that a great many men of scientific attainments had upbraided him with tergiversation when he made that statement, and I therefore leave it in the hands of the readers of the MACHINIST. What I *do* know is that the Pennington engines run cool enough with water jackets, having a ridiculously small water supply, and that they do not heat to any detrimental temperature when run with naked cylinders.

Fully realizing the factory side of the question, the Pennington motor is at present being developed on the line of augmentation by the assemblage of similar units; the 2 H. P. engine is simply a pair of 1 H. P. motors; and the 1 H. P. units are also grouped in fours, as shown in Fig. 10, to produce a nominal 4 H. P. motor indicating about 16 H. P., the cylinders being inclined in pairs so that two of the trunk piston rods lay hold of one crank on each side of the combination of elements.

It will be observed that the cylinder proportions of the engine are not at all the common square of the gas engines, 2½ inches cylinder diameter by 6 inches stroke forms the standard unit. But a much greater digression is shown in an engine now under test, having a 2½-inch diameter with 12-inch stroke single cylinder, in which the terminal pressure is reduced almost to atmosphere, with a fuel gain of about 45 per cent. over the 2¼″ x6″ cylinder dimensions.

Referring to Fig. 1 there is next to nothing in the way of description or explanation to give. The oil admission is simply a screw-controlled needle valve. I saw a blue print of the igniter, but it was refused for publication, and I can only say that it is very simple and gives no hint of its two-current refrigerating powers. The cylinders are made of steel tubes ground inside in a primitive engine lathe and steady rest rig, dry and almost certainly not a very close approximation to a cylindrical form. The pistons, I was told, were drop forgings. They would be more easily made in gray iron. The piston rings are gray iron, less than $\frac{1}{16}$ inch thick, with halved joining. The pistons and open cylinders appeared to be wholly free from any deposit, and were bright and clean. The trunk pistons are a very slack fit in the cylinders, perhaps $\frac{1}{32}$ inch small. The workmanship generally was fair, and the designing was specialized with a very high degree of ingenuity, as I need not say when it is remembered that a 58-pound locomotive makes a mile in 58 seconds on a street pavement. I hardly think there will be a dissenting voice from the assertion that this feat of the Pennington motor cycle is one of the most marvelous achievements of mechanism ever seen.

Mr. Pennington himself, "Air Ship" Pennington as he delights to be named, was born in 1858, and at the age of thirteen became an apprentice in the shops of J. A. Fay & Co. in Cincinnati. He was for eight years in the shop, and then began ventures of various magnitude on his own account. He first thought of air ships in 1885, while President of the Pennington Machine Works at Fort Wayne. He built his air ship in St. Louis in 1890, which is a matter of prominence in aeronautic history, and also in 1890 first applied the gas engine to a road vehicle. He has been ridiculed as "Air Ship Pennington," wears the name boldly, and probably with that faith which moves mountains.

In reply to a question as to his own idea of aerial possibilities, Mr. Pennington said: "Suppose I have a cycle, screw driven, making a mile a minute; just suppose that; then suppose I put aeroplanes on that machine, and they are well arranged and under good control, what then?"

Pennington's 2 H. P. motor weighs 17½ pounds, and his entire "Victoria" weighs less than 400 pounds, of which perhaps 140 or 150 pounds belongs to the motive power and reducing gear. The Pennington Victoria will easily transport a load of 800 pounds, making a total weight of 1,200 pounds.

The passenger on the demoniacal tandem feels the impulse of each stroke of the engines, just the same as on a little stern-wheel steamer; aboard the "Victoria" the heavy fly wheel equalizes the motion, and the individual piston impulses are not distinguishable. The kerosene is carried in the long tube on top of the dashboard, and passes through the tubular framing of the body to the motors. The motors themselves are, as is evident from their construction to all in the least acquainted with gas engines, of the 4-piston stroke cycle variety, and make one outboard working stroke and one inboard, idle, cylinder clearing stroke, then an outboard charging stroke and an inboard charge compressing stroke in sequence; the valve operating crank is driven by a pinion and spur 2 to 1 reducing gear on one side, with a cross lever transfer to the other cylinder. With the 6-inch stroke cylinder the exhaust is very audible, though not disagreeably so. With the 12-inch stroke cylinder the noise of the exhaust is not noticeable. There is no visible discharge of vapor, and no evident odor except in case of an over admission of oil, and an over admission of oil leads to an immediate loss of efficiency which makes its continuance an impossibility. The one great mystery is the coolness of the naked cylinders, which should be red hot at the end of the first twenty strokes or so of a run. Chemists are familiar with the establishment of low-temperature pressures, but pressures established by explosion are not cold as a rule, and the gas engine has always been hot.

The Kane-Pennington shops are making or have made general trials of the water-jacketed cylinder; the 2½″x12″ expansion engine is jacketed and piped with top and bottom natural circulation pipes to a small water tank which a run of some length did not seem to heat very much. The cylinders run perfectly well naked, with no cooling element more than their inevitable exposure to the atmosphere. There is evidently some heat absorbing or diverting or abstracting element or operation in the Kane-Pennington engine not commonly present in the gas engine, and it is difficult to see what this can be, if it is not the truth that the heat of the cylinder walls is absorbed by the incoming charge previous to the moment of the ignition, or else transformed into work on the piston, as it seems impossible that the gases after ignition should be otherwise than very hot indeed. Cards from the 2½″x 12″ motor are promised, and these may give some clue to the thermal conditions of the Kane-Pennington motor in action.

Double Side-Planer.

This machine was built for the Atlas Engine Works, was designed for planing connecting rods and similar work, and has two heads on each arm. Each end, or each planer, is driven separately, and it can be used either as a single or a double planer. The maximum space between the tools is 8 feet and the minimum 20 inches; each arm extends and will plane 26 inches wide.

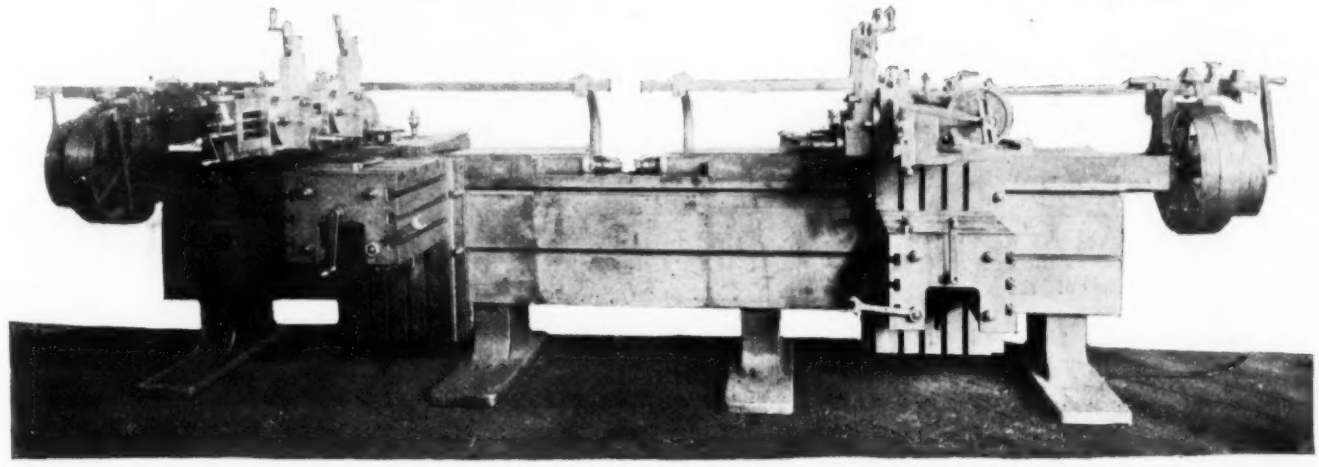
The inside tool slide is arranged to run back over the saddle, out of the way when using one tool.

To make this machine convenient to operate, the stopping, starting and stroke-adjusting device is placed on the outer end of the moving arm in easy reach of the operator.

When stopping the machine it is not necessary to stop the countershaft, but merely to move the rack operating the belt shippers, thus throwing the belts on the loose pulleys of the machine, and at the same time locking them, so that they cannot be moved from any other place than the hand wheel that is used for starting and stopping, and which is shown, one upon each saddle.

The device for lengthening or shortening the stroke is just beside the hand wheel, and consists of a circular plate, having an angular T-slot turned in it, projecting from which are movable stops, which are attached to this plate by a suitable bolt, fitting in the annular T-slot, which can be securely fastened to the desired position for the stroke of the planer. Against these stops is a swinging arm that is operated by gearing, which nearly makes one revolution to the full length of the planer. So by setting these stops for full stroke or any desired distance a very positive and quick-acting belt-shifting device with the locking features is obtained.

The saddle is securely gibbed with taper gibs on the under side, and has a long wide bearing on the top of the bed. There are four bronze nuts which are used to drive the cut, as these have been found to be more satisfactory than one long nut. By using four nuts in this way any tendency to heat is obviated, and a better chance for lubrication is obtained. The power screw is 3 inches diameter, cut double thread, one per inch.



DOUBLE SIDE-PLANER.

Each end of the screw has a square shank on which to place a crank, so that in setting up gibs, etc., the screw can be turned by hand to feel just what pressure is on them.

This particular machine has only two tables, it being made for special classes of work; but in case a long platen is desired it could be attached to or on top of the square tables. This machine is built by The Pedrick & Ayer Co., Philadelphia, Pa.

Railroads in China.

Seventeen years ago there was but ten miles of iron tramway in the whole Chinese Empire, and this tramway ran from the Karping coal mines (a distance of eighty miles from Tien Tsing) to the sea. The motive power on this line was coolies, who loaded the cars with coal, pushed them down to the sea, unloaded them, and pushed them back again. The length of a day's work was at that time twelve to fourteen hours, and the wages ten cents (Mexican) per day.

About that time the works were put in charge of a young English engineer who was restless, enthusiastic and modern; who was totally unacquainted with Chinese lethargy or the conservatism of their institutions. He proposed many changes in order to facilitate the work and decrease the

expenses, but owing to Chinese prejudice the authorities at Pekin promptly vetoed his attempts at progressive measures.

In spite of these measures he had made up his mind that he would have a locomotive. To have it was to build it himself. Consequently, the workshop in which the first locomotive in China was built was a mat shed. The tools at his command were few; four small driving wheels were ordered from the United States; an old stationary engine furnished the boiler, and a broken-down winding engine the cylinders. The result was that the "Rocket," as this engine was named, was an object curious to behold to the Chinese as it flew over the track, its sides emblazoned with large yellow dragons.

In due course of time the Pekin Government heard of the innovation, and consternation reigned at the Weather Bureau, as it was thought that it would cause displeasure to the spirits of the air, and as a result it was summarily ordered to be suppressed. It was then used for short trips in the yards, and gradually the length of its travels were extended, until at last an Imperial decree was granted for its free use. This young Englishman is to-day the chief engineer and general manager of the Chinese railroads; his name is C. W. Kinder, familiar to all railroad men in America.

The rails used to-day in China are 60-pound steel, Sandberg pattern, and are made at Barrow, England, and are delivered at Takee for less than $21 per ton.

The main shops are at Tang-Shan, and consist of shops for the repair of cars and locomotives, and for the construction of rolling stock. They build all their cars, both passenger and freight; also tenders for locomotives. The locomotives themselves are of English and Scotch make, with the exception of one, which was built by the Grant Locomotive Company.

The engines are of the Mogul type, and are fitted with powerful steam brakes on the drivers. They have tried to use American cast-iron wheels, but the results were not as satisfactory as those secured from the use of the European steel tire wheel.

Every car has a brake at each end worked by a screw, and as yet no continuous brakes have been used, although two trains were once fitted with the Westinghouse system, but, owing to some trouble in manipulation, the directors failed to adopt the system.

There is one detail in the rolling stock that is American—all cars have the Janey couplers, and it is a source of regret to the manager that he cannot manufacture these but has to pay the American price for them.

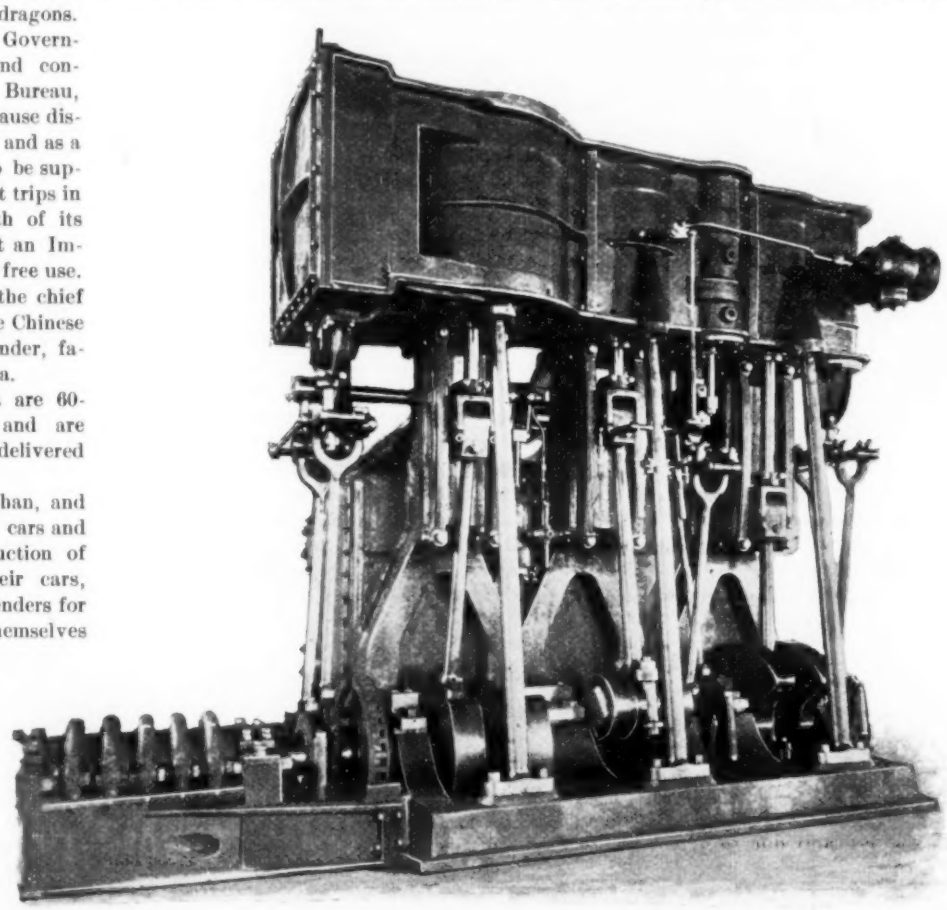
A. F. TENNILLE.

Engine of the Steam Yacht "Free Lance."

With this we give an illustration of the engine for the steam yacht "Free Lance," built for F. A. Schermerhorn, of New York, by Lewis Nixon, at the Crescent Shipyard, Elizabethport, N. J., from the designs of A. Cary Smith, of New York, the engines being designed by Charles C. Bowers, superintending engineer of the shipyard.

The engine is of the inverted direct-acting triple-expansion type, with cylinders 11, 17 and 29 inches diameter and a stroke of 20 inches. The cylinders are mounted in the order of high, intermediate and low pressure, with the H. P. valve on the forward end of the engine, the I. P. valve between the H. P. and I. P. cylinders, and the L. P. valve on the after end of the engine. The steam ports in H. P. cylinder are 1¼x9 inches; I. P. cylinder, 2¼x17 inches. There are double ports in the L. P. cylinder, each 1¼x30 inches. The throttle valve is balanced and fitted with a relief valve. The H. P. cylinder is fitted with a piston valve 6 inches diameter; the I. P. cylinder, with two piston valves each 6 inches diameter, and the L. P. cylinder, with a large double-ported D-slide valve. The piston valves have self setting spring rings. Liners are fitted to the steam chests of the H. P. and I. P. cylinders, and the L. P. steam chest has a false seat or liner for the slide valve to work on. All valves have 4-inch travel and are worked direct by the regular Stevenson double-bar link. The valve stems of the H. P. and I. P. valves are 1⅜ inches diameter, and for the L. P. 1¾ inches. They are made of steel and work in guides fitted with brass bushings. The eccentrics are of cast-iron 2 inches wide for the H. P., and 2¼ inches wide for the I. P. and L. P. cylinders, with cast-iron straps.

The H. P. eccentrics are fitted to the end of the shaft which is turned down to 2 inches diameter to receive them, thereby allowing the use of eccentrics of much smaller diameter than those of the other cylinders. The engine is supplied with steam reversing gear having a cylinder 5 inches diameter, 10 inches stroke, and fitted with gag for adjusting the cut-off; all are under easy control of the engineer. All pistons are cast steel disks 3 inches deep at sides and attached to the rods by a quick taper and nut. All the pistons have two rings side by side backed up by a third ring of the same width as the two outside ones, and in the L. P. piston the three rings are reinforced by nine helical springs 1 inch outside diameter, and about 1¼ inches long, made of ¼ inch brass wire. The cylinders are carried by the condenser at the back, and three wrought-iron columns in front, which form the frame of the engine. The bed plate is of the girder type 7 feet 8⅜ inches long conforming to the shape of the vessel, and has 5 main journal bearings. The crank shaft is of solid forged steel 6 inches diameter. The cranks are placed 120 degrees apart in order of H. P., I. P. and L. P., and are counterbalanced. The thrust bearing has six collars forged on. All crank-pin brasses, main bearings and eccentric straps are lined with anti-friction metal. The condenser is of cast-iron 6 feet 11¼ inches between the tube sheets, and has 602 brass tubes ⅝ inch diameter; the tube sheets are ¾ inch thick. A rotary circulating pump 18 inches diameter, with blades 3 inches wide at the root tapering to 1¼ inches at the outer ends, is bolted onto the end of the condenser and run by an independent engine with a cylinder 5 inches diameter by 5 inches stroke; also bolted to the condenser and attached direct to the shaft of the circulating pump. The air, feed and fire pumps are all independent. The engine is finely and substantially built, and for the speed and power it developed takes up very little space, and all parts are within easy reach of the engineer. The engine was built by S. L. Moore & Sons, Elizabethport, N. J. The dimensions of hull are as follows: Length over all, 137 feet; on water line, 108 feet; beam, 20 feet; draught, 6 feet 9 inches.



ENGINE OF THE STEAM YACHT "FREE LANCE."

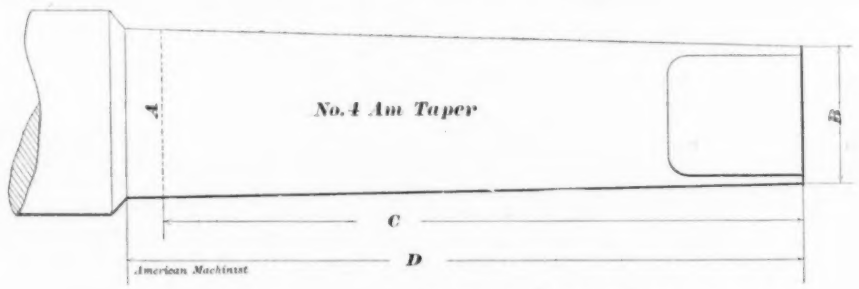
The "American" Taper Shanks.

Some time ago we received from one of our friends the following inquiries:

1. What is the origin of the so-called American taper?

2. What concerns now use it for holes in machine spindles?

3. What is the size at small end, depth of hole and taper per foot, also thickness and length of tenon on the Nos. 1, 2, 3 and 4; the No. 5, I understand, is the same as the No. 4 Morse taper.



AMERICAN TAPER SHANK.

Having the impression that the ¾-inch per foot taper used by Wm. Sellers & Co. had been sometimes called the American taper, we wrote to the manager of their works, Mr. J. Sellers Bancroft, and received a letter in which he says: . . .

"I wish that the 'American Taper Shank' was ¾ inch to the foot, but, unfortunately, it is nothing definite.

"In our early practice we used a taper of ¼ inch in diameter per foot of length with the end of the drill flattened to enter a corresponding slot in the chuck; this gave so much trouble from these flat ends twisting off and from jamming fast in the chuck from heavy cutting, that in 1862 or thereabouts we abandoned this arrangement and keyseated the drill shanks, driving them by a key firmly imbedded in the chuck, at the same time we changed the taper of the shank to ⅝ inch diameter per foot of length; this we have used ever since with very satisfactory results.

"My recollection is that the first twist drills made for the market were made about ½ inch taper; that this was afterwards superseded by the Morse taper of shank, which is about ⅝ inch per foot, but the taper is not uniform for the different sizes of shank. I think you will find that this is called in various articles in back numbers of the MACHINIST the 'Morse or the American Standard,' and is the standard that tool builders generally have conformed to as nearly as the inaccuracies of the model would permit. You will also find that the twisting off of the end of the drill is a constant source of annoyance."

In the older catalog of the Morse Twist Drill and Machine Co. this "American Taper" is referred to; but later catalogs do not mention it and the company informs us that there is now very little call for drills or other tools with shanks of that taper.

Mr. E. S. Taber (president and treasurer of the company) writes us that "The 'American Taper' had its origin in Newark, N. J., with the Manhattan Fire Arms Co." This company, we understand, went out of existence long ago.

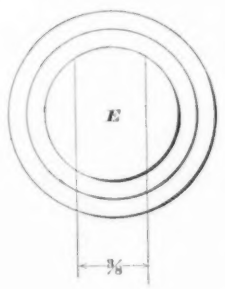
Mr. Taber sends us a sketch and table of sizes which are given below:

No.	A.	B.	C.	D.	E.	Taper per foot.
1	.3985	.2845	2 5/16	2 3/4	3/8	1/8
2	.534	.3965	2 13/16	2 7/8	3/8	1/8
3	.713	.563	3 1/16	3 1/8	1/2	1/8
4	.8965	.730	3 7/16	3 5/8	5/8	1/8
5	1.231	1.000	4 1/2	4 3/4	11/16	1/8

Some Examples of Questions—Turning Rubber Rolls—Repairing Stillson Wrenches.

A correspondent, who says he is an apprentice, asks some questions as follows:

I have some rubber rollers 3 inches in diameter and 6 inches long, with iron shafts through the center, and they have a ring about ⅛-inch deep worn in them, and I want to turn them off smooth and straight so as to get that ring out. Can you give me some help as to how I can do it? *A.*—The rolls may be easily turned with coarse sandpaper. Mount the rollers on the centers in a common engine lathe, and run on the fastest or next to the fastest speed of the lathe. The sandpaper should be held or clamped tightly over a cylindrical surface parallel to the roll. A piece of iron or wood 1½ inches in diameter and 4 or 5 inches long fastened to the rest in any convenient way will do to carry the sandpaper, using a strip 2 or 3 inches wide. The rest may be moved back and forth by hand, taking light cuts until the worn place in the roller disappears. 2. I also ask you for the best method of sharpening Stillson wrenches on the shaper and what angles they are; please give cuts of tools, etc., and you will oblige an apprentice. *A.*—Now it seems proper for us to say that, while the previous question was a perfectly proper one, because it asked for information not generally known or easily attainable, this second one is not a proper one for an apprentice to ask, at least in this exhaustive way, and for the same reason it is not a proper one for us to answer. The making and repairing of tools is one of the best opportunities the apprentice has for learning the trade, and the learning that he



gets in this way is not very effective if all the thought and investigation is done by someone else. As to the angles of the teeth, if the apprentice will examine the jaws of a Stillson wrench that is in good condition, he will be able to ascertain the angle of the teeth better than we can tell him, unless we hunt up a wrench and do this investigation for him, and by so doing we would be defrauding him out of a little independent investigation that would be most beneficial. The jaws should, of course, be thoroughly annealed, and if he will read our editorial of July 4th, on annealing steel, that article contains so nearly all that we know on the subject that it would be no benefit to anybody for us to go over it again. As to the tool most suitable for planing the teeth, that of course we cannot answer, as we do not know the machine upon which the work is to be done or in what way the pieces can be chucked in it. The tool may be a plain straight tool with the point of the right shape for the tooth space, or it may be a projecting cutter in a tool holder, the latter probably being the best if everything is all right. The teeth will probably need some filing after they are planed, and that operation no man living can tell a fellow how to do. Like many other things it can only be learned by actually doing it, and not always doing it perfectly the first time that it is attempted. If an oculist must spoil a hatful of eyes before he becomes an expert, a repairer of Stillson wrenches should not be really discouraged until he has spoiled about a bushel of them, and if the first one should come out of his hands successfully rejuvenated, he would have something to regard with considerable satisfaction. The last operation, the re-tempering of the teeth, is the most important of all. It should not be attempted by an apprentice until he has at least seen the tempering operation successfully and properly performed. The operation requires care, and the kind of care that comes by experience. The heating is to be done slowly and to the right heat, which is itself to be judged correctly only by a trained eye. It is not easy to heat a piece with sharp teeth on it without overheating or burning the points of the teeth, but with care and patience it may be done. When the piece is exactly at the right heat, which can only be judged by the eye, it is to be cooled as quickly as possible, and in this case we would say preferably in clean water. After it is entirely cooled it is to be brightened so that the colors will readily show in drawing the temper. It is easy enough to say that the temper should be drawn to a beautiful red, approaching the blue, but the operation is a most ticklish one. The heat should be applied back of the teeth, either by hot tongs or by laying upon a hot iron, and the piece should be so manipulated as the color is seen to approach the teeth that it will reach them all at the same time. When the teeth actually begin to change color they will change very rapidly, and at the critical moment the piece must be plunged into the water to arrest the drop of temper, and when it is cold the operation is completed. We have known a plenty of apprentices who have undertaken such jobs as this and carried them through successfully, and those who have afterwards developed into the best mechanics are those who have watched operations and thought out the connections between causes and effects, and the best methods of accomplishing desired results, rather than those who have trusted to others to do the thinking and the investigation for them. There is nothing more necessary than the asking of questions, but first question things, next question books and current literature and last of all question men, but question either unflinchingly if the answer is not obtainable from the other.

By an unaccountable oversight the symbol *g* representing the acceleration by gravity was replaced by the numeral 9 all through Mr. Goodenough's article published in our issue of October 24th. Of course those who are familiar with the subject will not be misled, but others may have been.

Reamers—Countershaft Hangers—Projection of Drawings—Monkey Wrenches.

BY OBERLIN SMITH.

Apropos of reamers, and especially of the recent very interesting description in the MACHINIST, of the unusually large ones used by Mr. Bullock for boring Willans engine cylinders: who knows much about reamers any way, and why does not somebody find out more about them by accurate and critical experiments? Would not this field of investigation be a good one for some of the experimenters in our technical schools?

A reamer seems to the incautious critic a very simple tool, and yet to the experienced reamerer it seems to possess almost infinite capabilities of good and evil. The question has doubtless occurred to almost all of us,

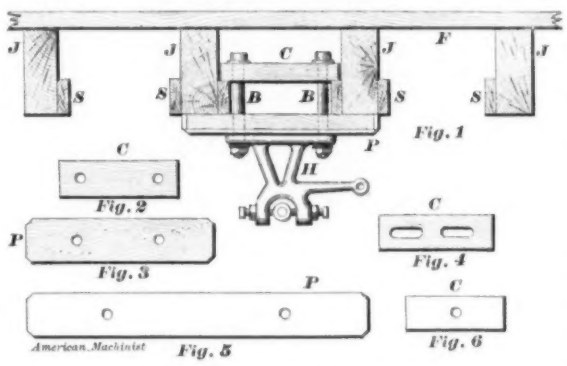


Fig. 1. Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6.

COUNTERSHAFT ATTACHMENT.

why something that seemed to be a most beautiful reamer would not permit anything to be good about its products, and why some of the old, flat reamers referred to in the article in question, with their wooden sides, seem sometimes to do much more excellent work. Such a result could not, of course, always be entirely depended upon, but when everything did happen to be right the good effect was probably due to a pair of sharp parallel cutting edges being held nearly enough in an axial plane for all practical purposes by the wooden side pieces, whose purpose was more than that of merely locating the tool proper. Their additional function was doubtless to form a somewhat elastic cushion, which would neutralize the vibration of the cutting edges in the work, which is often so annoying—with its fluting and chattering effects.

The rather peculiar two-jawed reamer, described in the article referred to, with its four guiding plates or "bearers," would not seem at first sight to be the best possible form for such a tool. It is, however, very gratifying thus to learn the details of tools which have come up through a course of evolution to give such excellent results by literally adapting themselves to their *environments*. It would be interesting to know further whether various other numbers of bearers, arranged at different angles, have been tried, and just what were the comparative results.

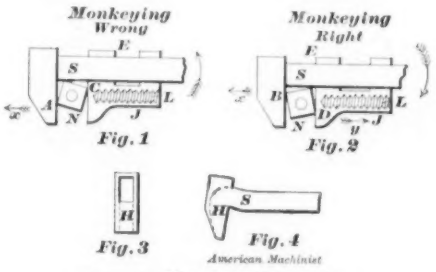
The first question that would naturally arise in analyzing a reamer of this kind, would be whether the edges of the bearers form elements of a true cylinder, and if the edges of the cutters are also elements of this same cylinder. If so, how can they do any cutting in a hole which is already large enough to admit the bearers? If, on the other hand, the cutter edges form elements of a larger cylinder and project beyond the bearers, how can the bearers fit tight enough in the larger hole thus made by the rotating cutters to guide the tool, make it revolve upon a definite axis, and prevent it from shaking and chattering? The answers to these questions undoubtedly can be derived only from the fact that the reamer itself is elastic as well as the metal in which the hole is bored, and that certain waves of radial motion must occur in both tool and work to enable such a reamer to go into the hole at all or to do any cutting after it gets in. Practically it has shown itself capable of producing a good hole, although if such a hole could be microscopically surveyed all over, it would doubtless show somewhat startling variations from its ideal form.

From a purely theoretical standpoint the perfect reamer would seem to be one with numerous spiral teeth, whose edges should lie absolutely in the surface of the cylinder, except where they become conical at the entering end. If the materials of tool and work were not elastic the cutting would, of course, all be done upon the conical part, ceasing absolutely where the cone joins the cylinder—the straight part of the teeth beyond that point acting simply as guides. The perfect action of such a reamer would, obviously, depend upon the work being absolutely stationary, as well as the axis of the reamer. In real life we get neither of these conditions, nor do we get non-elastic substances. We therefore must expect the cutting of a reamer to be a sort of a compromise between the ideal just set forth and the crowding of a footballist through a piled up mass of his fellow sufferers. There is, however, as before intimated, a large and interesting field for careful experiment in regard to the best possible designs for boring tools of various kinds.

COUNTER HANGERS.

In the August 22d AMERICAN MACHINIST is shown an excellent method of fastening countershaft hangers to a ceiling which seems to be especially adapted to cases where the shaft runs at right angles to the joists. This reminds me of a still cheaper and equally convenient method used by me for a great many years past for putting up countershafts, which, by the way, happened in most of the cases concerned, to be parallel with rather than across the longitudinal lines of the joists. When otherwise, short, supplementary scantlings were bolted crosswise beneath.

In Fig. 1 is shown a vertical cross-section of an upstairs floor *F*, with joists *J J*, having strips *S S* nailed upon either side of them, flush with their lower edges. These are usually of 1-inch pine boards 3 inches or 4 inches wide, of a cheap quality, such as is used for shingling laths, etc. They are fastened up with plenty of tenpenny or twelvepenny nails to the joists in question, which in my case have usually been of 3″x12″ hemlock or yellow pine timber. In some cases these strips have been put up only where a line of countershafts was supposed to be needed, but as these have from time to time been shifted, other strips have been nailed in to suit. Later it has been my



USE OF MONKEY WRENCH.

custom in putting up a new set of joists, to equip them everywhere with these cheap strips, so that any countershafts can be put up in any position whatever, in reference either to the length or width of the room.

The holding of the hangers *H* by the bolts *B B* dropped through a pair of washers, and through the rough wooden clamp *C*, Figs. 1 and 2, thence through the wooden plate *P*, Figs. 1 and 3, and thence through the hanger, washers and nuts, is clearly shown in the pictures referred to. The clamps *C* are usually of 1½-inch by 4-inch or 5-inch or 6-inch "stuff" roughly sawed off to length. The plates *P* are of the same stuff, but preferably a little wider, and are usually roughly planed, beveled and painted upon the bottom and edges. Almost any kind of wood is good enough, except hemlock, which for sentimental and emotional reasons at any rate (if not directly practical ones) should be left out of all engineering constructions that are liable to be handled by thumbs and fingers of flesh. Possibly some of the prejudice against this rather useful product of the forest comes from the ancient tradition that after the Creator had made all other kinds of wood the devil obtained permission to try his hand, and evolved—hemlock!

In some cases the clamps *C* are made with slots instead of round holes, as in Fig. 4, which enables them to be used interchangeably for hangers of various sizes and patterns. The plates *P* are, of course, in such cases, slotted in the same way.

It is sometimes desirable to put a hanger directly or partially under a joist, or to put up an unusually large hanger, or any hanger with unusual stiffness. In such cases a double length plate *P*, Fig. 5, may be used, attached to two clamps, placed in two respective joist spaces, with one hole in each, as in *C*, Fig. 6.

Any of these arrangements are extremely convenient for shifting one or both hangers of a countershaft, and for the original locating thereof, regardless of what odd length the shaft may be. They are also useful for light line shafts.

DRAWING PROJECTIONS.

In a recent article by "Untutored" I am mentioned as having "a too vivid imagination" when sliding my object in connection with its revolution. The alleged method shown in his sketch, Fig. 1, of revolving without sliding must itself, I think, be considered but a figment of the imagination, as a sliding or soaring or flying (or whatever it may be called) process, through the air, must have been used previous to the revolution, as an alternative of the sliding upon or above the drawing originally spoken of by me. In other words, a lateral as well as a rotary motion must necessarily be used to get the object into the various positions shown in his Fig. 1. To speak of this lateral motion as not a sliding one is simply begging the question.

The principal mistake made by the correspondent in question, however, is in his signature, which should be "Tutored" instead of "Untutored," as he has shown himself thoroughly acquainted with his subject, and well equipped from a literary point of view for its discussion, even if his logic may seem to some of us a little lame. Is it possible that a state of mind like this may have resulted from an imagination which has been tortured as well as tutored?

MONKEY WRENCHES.

I am constrained to differ somewhat from a correspondent in the August 29th MACHINIST in regard to the abuses and consequent diseases of monkey wrenches. Referring to Figs. 1 and 2, it is true that the eye at *E* sometimes tears out, but this is a matter so easily remedied in the manufacture by making the eye a trifle thicker all over, in cases where it has proved too weak, that it is hardly worth discussing.

It seems to me that the most usual accident to a monkey wrench is the bending of the stem *S*, as shown in Fig. 4, for it is a rare thing to see an old wrench where the head *H* has remained at right angles to the stem. The cause of this bending, except perhaps in the case of some abnormally strong wrenches, is obvious. The stem in question is acting as a projecting beam with the usual greatest stresses at or about the point of support. This, in the present case, is the nut *N*, which is, of course, making an attempt to remain stationary. Were this beam continued logically into the head in parabolic form, as shown by the dotted lines in Figs. 3 and 4, then the bending action in question would be as liable to take place at *H* as at *S*, but as the head, for other reasons, is made larger and stronger, the greatest deforming stresses are, of course, concentrated at *S*.

The reason why a wrench is more easily spoiled by moving it the wrong way, as in Fig. 1, than the right way, as in Fig. 2, is because there is a violent spreading action between the jaws caused by the nut *N* acting as a cam, which in Fig. 1 pushes out

ward at *A*, in the direction of the small arrow *x*, while the leverage to bend the beam at *S* is much greater than where the outward force is at *B*, as in Fig. 2. In this second and correct method, the inward thrust, in direction of arrow *y*, of the cam-like nut, is given at *D* rather than at *C*, with more leverage, it is true, than before. In this case, however, the said thrust is not so much trying to bend the stem at *S*, as to slide the moving jaw *J* along upon the stem. This jaw, having for its abutment the adjusting screw in the line *L*, and being moreover of well-braced and rather strong proportions in itself, does not suffer by the change in position of the point of thrust.

The cam-like action referred to, which is exercised by the nut, is, of course, worse as the nut is smaller, even with a given torque exercised by the hand of the monkeyer, on account of the shorter leverage in said cam from its center outward at right angles to its line of thrust. Thus a hexagon nut is worse than a square nut of the same nominal diameter, and for like reason a small-headed set screw is worse yet. One of the greatest abominations in a small way in machine-shop practice is perhaps the habit of using a wrench of the kind in question for taps and reamers, which usually have very small heads, often with the corners badly worn off, and which require a heavy torque. This rascally process is practiced in almost every shop, in spite of all that is said against it, and is one of the most dangerous epidemics to which monkey wrenches are liable. Especially is this the case when they are used in the wrong direction, as shown in Fig. 1.

LETTERS FROM PRACTICAL MEN.

Speed of the Wrecked Wheel.

Editor American Machinist:

Please inform me if your account in the last AMERICAN MACHINIST about the fly-wheel accident at Hoboken is correct. It does not correspond with the one given in the *Engineering Record*. According to your data, the wheel was running at a normal belt speed of 7,850 feet, which is unusually high. C. E. B.

[The speed of the wheel was 100 revolutions instead of 125, as we stated; the diameter, however, was 20 feet, as we gave it, instead of "about 17," as in the journal referred to, so that the belt speed was 6,280 feet per minute. We thank our correspondent for calling attention to the matter.—ED.]

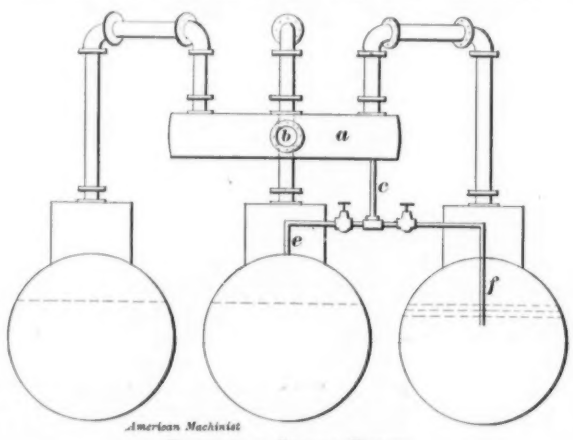
Experience With Gear Molding Machines.

Editor American Machinist:

Much valuable information has been printed in your paper about the detailed method of fastening gear teeth to the pattern. I have had considerable experience with gear patterns, part of which certainly left a bad taste in my mouth; old "relics" that used to do certain work on certain machines were unearthed in our pattern "museum," and sent to the foundry; well the wheel was cast, and when set up was found one-half inch or so out of true circle; as we were not in the elliptical gear business, we naturally turned off about half the tooth to get the thing "round." We learned then that big gear patterns when stood on the rim for several *years*, more or less, get quite a "bulge," and ought to be "trued up" before making in iron. Our pattern shop was ample, but our storage facilities limited, thanks to our relics of bygone days, and as the man who could give the order to clear out patterns that had not been used for 20 years, was not in the humor to do it, and he also forever "kicking" about pattern time on the many gears which we made, we began to imagine a sort of heaven where it was too hot for iron to stay solid. After many months "uphill" fighting, I persuaded our people to buy a gear-molding machine, a thing that I had no experience with, and a sort of boomerang, which through any shortcomings on the part of the machine would surely back up on me. Even that innocent mechanism has its little tricks, as I soon found out. I had the mold "swept up" of proper diameter; that is, the outside diameter of the teeth, then started in with the index crank, revolving a long beam, one of such a number of parts of a circle as there were teeth. The pitch was rather fine, and we "rammed" the mold until the circle was completed. To strengthen my confidence I had a ring made of wood, divided in equal parts, the same as the gear ought to be; then laid it outside the mold, measured from the center along the side of each tooth to see whether they corresponded with my divisions on the ring. Did they? Well no, about the tenth tooth I could see that something was wrong, for two or three teeth I would be "full," then "scant," until I wished I had stuck to patterns.

The mold was torn down ready to try again; next time it was worse than before; so then it was time to look at the machine. I found the trouble; about a hair's clearance between the worm which revolves the machine and its wheel. While this was small it made quite a rattle at the end of a five-"foot" beam. I made a heavy spring then which kept the wheel hard against the worm—no more trouble from uneven teeth; but not being satisfied, I had for several successive gears rings made and divided, and, personally, crawled on all "fours" around that mold, when I found my hopes justified, and the machine "worked."

What a man can't think of when in trouble would fill many volumes. One day I sat watching the molder, and when he finished the last tooth I said, "turn her an extra tooth and see if the tooth block fits the first tooth you 'rammed.'" I had made a remarkable discovery; it did, showing that the teeth were spaced evenly, so the only problem that remains is, why I crawled around on the foundry floor so many times, when that extra tooth scheme checked the whole thing, and, mind you, I am not considered a fool either. Our pattern loft is still comfortably filled, our gears good, cheaply made, all teeth alike, and satisfactory in every respect. We made money with ours. CISNARF.



DRAINING STEAM PIPES.

Draining Steam Pipes.

Editor American Machinist:

I have a question in steam-pipe draining that I wish brought to the attention of the many readers of your valuable paper, in order to get their opinions or experience as the case may be through this same source.

The inclosed sketch represents the proposed construction of a battery of boilers. *a* is the receiver from the boilers; *b* is where the steam pipe leads off to the engine; *c* is a one-inch pipe for the purpose of draining the receiver of the water of condensation; the two branches *e* and *f* with a valve in each are thus arranged so that if one of the two boilers is out of service that branch may be shut off. As will be seen, it is proposed to convey the condensation back into the boilers by gravity, but men tell me that the water will not run back into the boilers as shown at *e*, claiming that the pipe must extend under the water as at *f*; others also claim that to make such an arrangement work it must be tapped into the bottom of the boiler. It is five feet from the bottom of the receiver to the top of the boiler.

S. A. SMITH.

Use of Hot Air for Drying.

Editor American Machinist:

In the "bicycle tool" article in the AMERICAN MACHINIST October 17th, we have an account of a kiln for drying the wooden rims after they have been steamed and bent. A circulating fan is shown, and we are told that "the circulation is continuous, the air drawn from the dry kiln being forced through the stack of live steam pipes back into the kiln again." I would like to know if this statement is correct in itself, and if it represents correct practice. There is no doubt that a plenty of people would do it in that way with the idea of saving heat; but it might better accomplish the purpose intended in this case to lose the heat. With the hot air circulating around and around, what becomes of the moisture that it is intended to carry off? The air, I suppose, does not become thoroughly cool at any point of its travel, so it does not get wrung out, or does not get a chance to deposit much of its moisture, and how the wood ever gets dry it is rather difficult to see. The heating and cooling of air, as I understand it, changes its capacity for moisture, and the greater the difference in temperature the greater will be the difference in water-carrying capacity. The air, if saturated with moisture when hot, is wrung out or relieved of the moisture by being cooled. If it is only partially cooled only part of the moisture is got out of it, and it will not be able to pick up as much when it is heated and passed into the presence of and contact with the damp wood again. Cold air, even if damp, may be heated up and then it is apparently dry and thirsty and readily absorbs all the moisture that it can reach until it is saturated, and then of course it will take no more, and that is the way that things are dried by hot air. If I had that drying kiln and the heating and circulating arrangement, I think I should take in cold air all the while through the heater and blow away the warm air after it had passed through the kiln. There may be other reasons that do not appear for using the same air over and over again, but so far as the absorption of moisture in the quickest time is concerned, I do not see how it will do it.

TECUMSEH SWIFT.

Radial Icicles.

Editor American Machinist:

I fully appreciate the compliment paid me in being set right by the best of authorities on centrifugal force. But if friend Porter will read my letter again carefully, I think he will discover that he has entirely misunderstood my statement, which I certainly endeavored to put in such language as would make any misunderstanding impossible. I would leave the question where it stands, were it not for the fact that it may be possible to point out the difference between what appears to be and what is.

There is no question but the appearance of water leaving a grindstone is as Mr. Porter has shown, nor is there any question but what the path in which a flying particle leaving the periphery of a revolving wheel will be tangent to the path in which it was traveling before it left the wheel. That is the appearance, and those the facts according to the premises stated, but both are entirely outside the question under discussion.

My statement was in effect this, "*so far as the wheel is concerned*, the water will leave the rim in approximately an involute curve, starting on a radial line."

To illustrate, assume a revolving wheel with radial arms and a deep rim. If a drop of water be placed on one of the arms, it will be caused to travel by the motion of the wheel round and round, and by centrifugal force along out on the arm of the wheel in a radial line; the results of the two being a spiral in fact as well as in appearance; but so far as the wheel itself is concerned in a radial line. When the drop of water reaches the rim, it will continue to travel out, as has been shown by other correspondents, in a radial line on the rim of the wheel. All this time the drop of water has been increasing in velocity. If now the velocity is great enough so that centrifugal force overcomes the adhesion of the drop of water to the rim, the water will fly off and take a path tangent to the spiral. But how does it leave the wheel is the question at issue, and I claim by continuing out in the same radial line it has been traveling on the arm and across the rim. After it leaves the rim there is nothing to increase its velocity, and hence it cannot go radially, but for an infinite distance, and at once falls back of the radial line and would strike an involute curve on a piece of paper fastened to the wheel if the water was a frictionless pencil, and had no affinity for the paper.

If I am correct in this understanding of what takes place, it does not upset any accepted fact, but it does change the statement from this: *When a particle leaves a revolving wheel by centrifugal force it goes off on a tangent*, to a statement like this: When a particle leaves a revolving wheel by centrifugal force, it takes *a path* tangent to *the path* it has been traveling in, or, a particle leaving the periphery of a revolving wheel by centrifugal force will go off the wheel on approximately an involute curve.

The pitch line of a rack is tangent to the pitch line of a gear with which it is in mesh, as is well known, and the teeth of the rack as they leave the wheel strike involute curves as is equally well known.

What I assume to be a fact, is that they leave in practically the same way a drop of water would if thrown off by centrifugal force.

Icicles forming on the outer rim of a revolving wheel are radial. They would form in involute curves were it not from the fact that as they form, they serve to impart increased velocity to the outflowing drops of water, which build up projecting radial structures. JOHN E. SWEET.

Syracuse, N. Y.

[We have a number of other communications on this subject, but think not much can profitably be added to what we have published, and that we have now devoted as much space to it as the subject calls for.—ED.]

Units of Force and Mass.

Editor American Machinist:

In his discourse on "Units of Force and Mass," Mr. G. A. Goodenough (October 24, 1895) seems to make a mistake identical with the one he is criticising. He speaks of length, mass and time as of fundamental units, while he classes force, velocity, acceleration, etc., under the category of derived units. The units of length and mass have been arbitrarily chosen, and are preserved in the English archives. They are capable of preservation, and, within certain limits of accuracy, of duplication. Of "time" he says: "The unit of time is, of course, the second."

The two words "of course" cover the error. What is a second? A certain portion of our average solar day, to be sure. But we know to a certainty that the rotary movement of our earth is subject to fluctuations which, although exceedingly small, are, nevertheless, a fact, and, moreover, a constant retarding tendency is known to exist. The second of to-day is not the second of a century ago, nor will it be like the second of a century hence. The change is exceedingly small, to be sure, but this is no excuse for adopting the variable second as a fundamental unit. In a purely scientific discussion the unit of time should be defined on a more scientific basis, and is undoubtedly a derived unit, owing to its dependence on motion.

The most rational line of defining the derived units is probably as follows: The standards of mass and length, which have been arbitrarily chosen, are the only fundamental units. Force is the next unit capable of definition by taking into account the element of gravitation. It should be referred to the attraction of two homogeneous globes, each of a given mass, located at a given distance. Then it becomes possible

to define the unit of velocity, as the velocity obtained by a body of a given mass, originally at rest, after a given force is applied through a given space. And finally, the unit of time can be defined as that portion of duration which a body of the unit velocity requires to pass through the unit of space.

In applied mechanics the units are not so defined. The second is adopted with reference to the practically (but not absolutely) uniform rotary velocity of the earth, just as the accepted unit of force is the terrestrial attraction, on the surface of our globe, of a given mass, termed the "pound," an attraction which is practically, but not absolutely, equal on all parts of the earth's surface.

Such discussions have, of course, little practical value, and both the units of time and force, as defined in applied mechanics, will perhaps always remain the units of the practical engineer. HUGO BILGRAM.

Philadelphia.

Eccentric Indicator Cards.

Editor American Machinist:

Accompanying this article are two indicator cards, taken from a single eccentric Corliss engine. One is taken in the ordinary way, and the other with the indicator cord attached to the rocker arm, or intermediate between the eccentric and the valve gear.

This will give about the same relative motion between the engine piston and the indicator drum as "Novice" suggested in his article in the AMERICAN MACHINIST of June 27th, present volume.

Such a card, without any explanation, would, no doubt, prove quite a puzzle to anyone not knowing anything of the manner in which it might have been taken. I have never compared cards taken in the above manner with other cards as to development, but in some other respects they are quite as valuable as cards taken in the ordinary way.

A little study of this curious looking card will enable engineers to read and understand all of the good points that such a card can possess, the most prominent of which are in the compression and admission lines.

The explanation by letters will make it easily understood, and to assist in this reference can be had to like letters on the ordinary card. a^1 and a^2 are where the exhaust valves close, and from a^1 and a^2 to b^1 and b^2 are the compression lines; from b^1 and b^2 to c^1 and c^2 are the admission lines; from c^1 and c^2 to d^1 and d^2 are the steam lines, and from d^1 and d^2 on around to e^1 and e^2 are the expansion lines.

The different ends of the cards are marked with the appropriate letters *H* and *C*, head and crank ends; they were taken with a right-hand indicator, thus making the head end of the engines showing on the left end of the ordinary card; the head end appearing on the right-hand end of the other card is caused by the motion from which it was taken, being so far in advance of the piston.

The humps in the steam lines are caused by the fact that another engine is working from the same pipe.

These cards were taken with a 50 spring, and the engine is 26x60x63 revolutions.

S. A. SMITH.

Steam Economy in Sugar Houses.

A writer in the *Louisiana Planter* contrasts the consumption of steam and fuel in two existing installations of sugar apparatus consuming the same tonnage of cane and producing the same weight of sugar. The plants are designated A and B, and the following results are arrived at:

	A.	B.
Total live steam, pounds	390,111	739,229
Total H. P. of machines	572	730
Mean steam per H. P., pounds	23.05	41.04
Total coal per day, pounds	48,763	92,404
Coal per 1,000 pounds sugar	650	1,232
Total boiler H. P	650	1,232
Boiler H. P. per ton of cane	1.3	2.465

Here we see that the coal bill of house A is only 53 per cent. of the account for house B. Taking the coal at $3 per ton, the daily coal expense is:

For house A	65.40
For house B	123.60
Difference	58.20

The coal expense per ton of cane is:

For house A	$0 138
For house B	0.247
Difference	$0.109

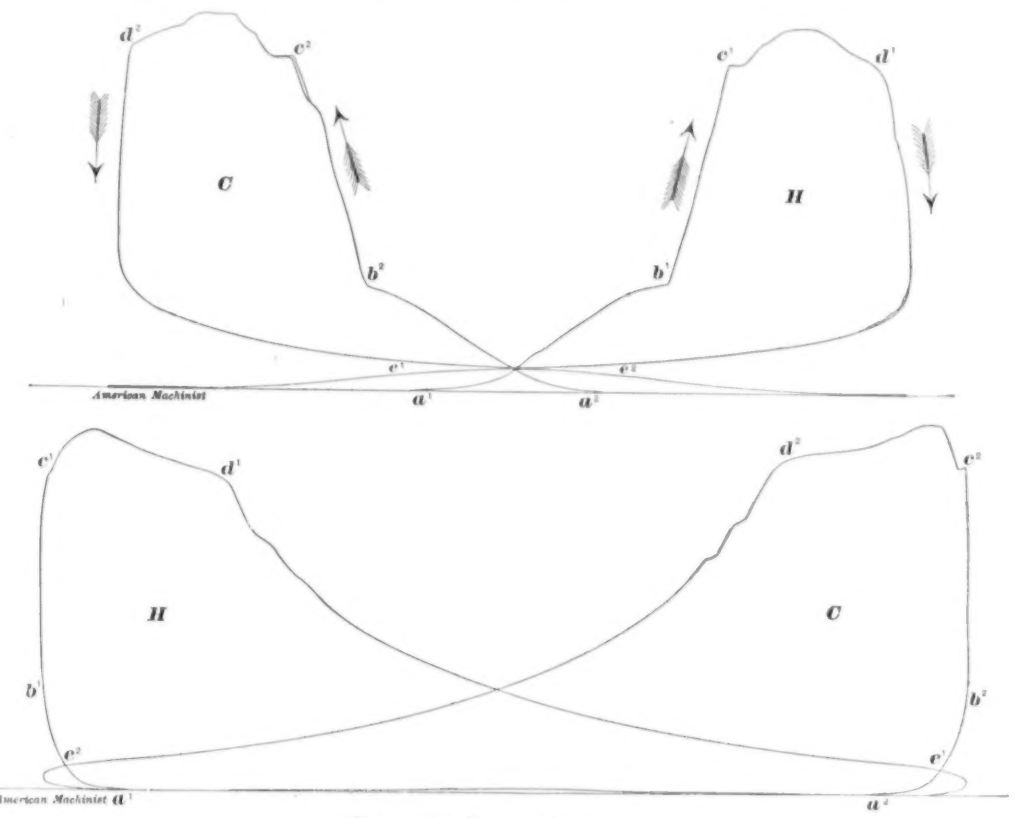
In addition to this attention is called to the difference in the first cost of the two plants. Assuming that $20 may represent the boiler cost per horse-power, the two steam plants show up as follows:

House A	$13,000
House B	24,640
Difference	$11,640

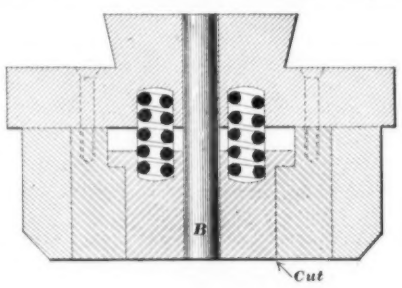
Then assuming the cost per horse-power for the various machines to be $10, we have:

House A	$5,720
House B	7,300
Difference	$1,580

Then the total difference in the cost for boilers and machinery becomes $13,220, which tells us quite emphatically what everyone should know—that the best is the cheapest. And this is as applicable to the men in charge of such plants as to the machinery of it. Usually the men who will work cheapest are the ones whose work costs most in proportion to its real value.



ECCENTRIC INDICATOR CARDS.



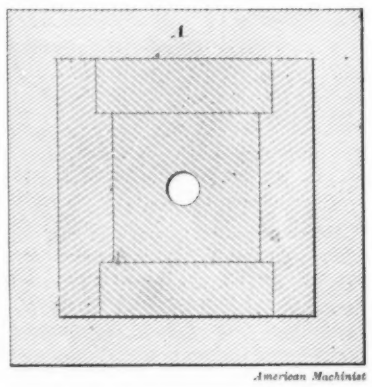


Fig. 1

Sectional Dies.

Dies of large size or of a difficult shape can usually be made to better advantage in sections, as in the former class the dies can be separately made and tempered and then set in their places in the holder, thus forming a complete die, requiring less stock; and should a part be spoiled in making or hardening, it can be easily replaced, whereas, in a solid die, the whole would be spoiled.

Sketch No. 1 shows a method of making a small compound die, sectional, that was adopted because it was found impossible to produce work that would meet the requirements of the case with the best solid die we could make. The pieces wanted were simply flat blanks of thin sheet-iron 2 inches by 4 inches in size, with a ¼-inch center hole, with an allowable limit of .002 inch variation. Very large numbers of them were wanted, involving the use of several dies that must not vary over .002 inch from each other, and after many trials with solid dies, which failed on account of the contraction caused by hardening, and also by the change in the die as it wore out, on account of the clearance given, a die was made like the sketch, the sides and ends of the die being made in separate pieces, hardened and ground to size, and held in place by the shrink ring *A*, the central punch *B* perforating the blank at the same time that the outside was cut.

No clearance was given the die as the blank is pushed out by the spring stripper, thus rendering the clearance unnecessary, and enabling the die to hold its size until worn out; this style of die gave such satisfaction that it was adopted exclusively for that class of work, and the extra cost of the die was more than offset by the decreased cost of the work produced.

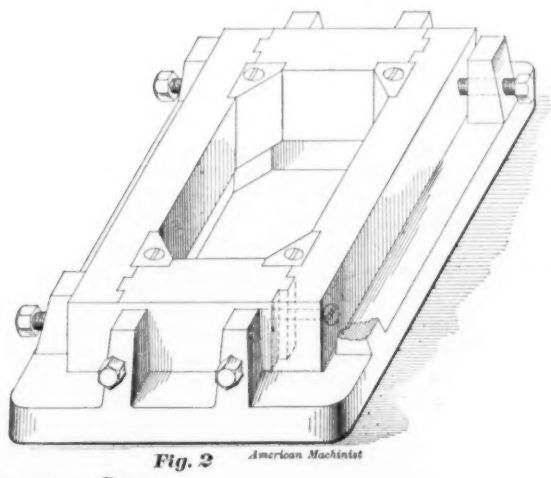


Fig. 2

SECTIONAL DIES.

I well remember the beginning of my experience on sectional dies, and, for that matter, it was my first experience on die work anyway. The firm where I was then serving my apprenticeship and being initiated into the mysteries of the machine business, took a contract to build a lot of large foot presses, or tin machines as we used to call them, for blanking out tin pans. This was before the introduction of drawn or struck-up tinware, now so common. They were fitted with six sets of dies each, made in sections, the punch being solid and secured to a cast-iron punch holder. The dies were held in place in a frame or holder which was too light for the work it had to do, and were also sprung badly in being improperly clamped in planing; as I had the credit of planing them I also had the pleasure of filing them true (?) with a hand planer, otherwise known as a 12-inch bastard file. There were, if my memory serves me right, sixty of them, and some of them were out $\frac{1}{32}$ inch or more. It took me three weeks to true them up, and it was three weeks more before my back stopped aching, but I think I learned more about planing than I ever have before or since in the same length of time. Large dies for armature disks, of which I will have more to say later, are invariably made in sections; both punches and dies are hardened and set in a steel holder, some of them containing over one thousand parts in both punch and die, and any die or punch can be removed and repaired without disturbing the rest. The first cost of a sectional die is usually greater than that of a solid one allowing that it could be made solid, but the certainty of its coming out right, without fire cracking or being distorted in being hardened, will offset the extra cost, and in the case of dies having a large number of parts that are precisely alike, by making special mills for them the die can be made with a cheaper class of labor, and still with the certainty that it will come out right in the end.

The second sketch shown (Fig. 2) is of a large punch and die that was made sectional from the fact that it was impossible to get steel of the proper size for the die as soon as wanted. The punch and die were both made in sections and ground to a perfect fit after being hardened. The dotted lines show the manner in which the joint was made, and better results were obtained from the die as to the cutting qualities and shape, than if it had been made solid. The size of the die was about 18 inches by 20 inches, and the stock punched was thin sheet-iron; the labor cost on the work, though somewhat more than it would have been for a solid die, was more than offset by the saving in the amount of stock used. The die was set in a cast-iron holder having eight lugs, which were fitted with set screws forcing the die firmly together.

J. L. LUCAS.

The Pittsburg Reduction Co. are bringing out a new alloy containing somewhat over 70 per cent. of aluminum, and which is said to be a practicable substitute for brass. It casts well; specific gravity, 3.15; tensile strength, 30,000 pounds. It works well in the lathe, polishes well, and retains its polish. Its color is white. This alloy, weighing about one-third as much as brass, corresponds in cost to brass at about 9 cents per pound.

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Juvenile Mechanical Periodicals.

A correspondent writes to ask us "if there is any mechanical journal published in English for the benefit of apprentices." The AMERICAN MACHINIST is generally considered to be a mechanical journal; it is published in English, as we understand the language; it is also published for the benefit of apprentices, and we have reason to know that many apprentices are benefited by it, so that in some respects the question is a strange one to come from one of our valued readers. If the writer is really looking for a periodical to be read exclusively by apprentices, his question is still more peculiar. We believe that apprentices are entitled to the very best of information, and the freshest of mechanical news; but what is good enough for them is good enough for anybody in the trade, or alongside of it, and all are hungry and alert, and we would not know how to keep the sheep out of our lamb pasture if we wished to try.

Of course we understand what it is that our correspondent thinks that he wants, and we could easily give an instance of the style in which the supposed want is sometimes catered to. We have an illustration right at hand. What is meant when it is said that steam in a steam engine has two or three, or eight or ten, or any given number of expansions? When steam is admitted into a cylinder for a certain portion of the stroke, and then cut off and allowed to expand by the advance of the piston to double the distance which it had traveled when the cut-off occurred, the steam is said to have two expansions; if it expands in the cylinder to four times its original volume it has four expansions, and so on. The expansion after cut-off may all occur in one cylinder, as in any simple engine, in the two cylinders of a compound engine, in the three successive cylinders of a triple-expansion engine, or in more than three cylinders, but in either case the final volume divided by the initial volume will give the number of expansions. That, it seems to us, is about all that need be said in answer to the question. But we might do as has been done quite recently, and spread this important information over two entire pages, with seven or eight cuts to make it clearer—you must have pictures for apprentices, you know, and that would be writing for apprentices, as some think that it should be done; but think of that for a month's dose of knowledge. How long would it be before the apprentice really learned in that way all the important points about steam and the steam engine, to say nothing of the myriad of other topics that he must master, some of them, in these days, of as great importance and magnitude and as difficult of mastery as steam itself? As a weekly journal, we, of course, have a great advantage over a monthly as a dispenser of information, but life is too short, and apprentices have too long a march before them to be delayed in "marking time" on the way. Every step should be a full step, and every step should count.

Suppose that we should begin to dispense elementary mechanical knowledge in words of one syllable, little lessons in arithmetic that can be better learned from a book of arithmetic and in the common school, the first principles of physics that are contained in hundreds of text-books, or should dilute and rehash a page or two of an encyclopedia every week, and, in short, get up a paper "for the benefit of apprentices," according to their idea of it, and suppose that we had succeeded in gathering around us a large constituency of apprentice readers whom we could look upon as our principal, if not our only patrons. We would soon be in the position of the man who should start a clothing business for little boys exclusively. He might make his clothes ever so nicely, and the boys might be pleased and proud to wear them for a time; but they would be growing up all the while, and they would begin to want men's clothes, and then the trouble would begin. They must come out in the full glory of adult raiment, and if the juvenile clothier could not supply them his customers would drop away from him at one end as fast as he could catch new ones at the other end. Another course would be open to him, which, if he were a sensible clothier, he would be quite sure to follow. He would have to begin to make men's clothes in self-defense, and in a very short time he would become a full-fledged tailor, with clothing still for boys, but also those for men of every age and of all sizes and conditions.

The illustration does not, however, fully apply to the case before us. In the knowledge that apprentices have to acquire there is no such distinction of juvenile and adult. There is no casting off of any of it as one grows older. The beginner is getting his knowledge for lifelong use, and he requires precisely the same knowledge that the most experienced men have, and the best place, and, indeed, the only place to get it is from the same common sources of knowledge. If there is any difference in the requirements the younger man should have the freshest, because he presumably has to carry it the farthest or to use it the longest, and the freshest is found in the columns of the journal that tells of the work of to-day.

Lawless Railroad Officials.

It would seem as though a little healthy legislation would be in order which would have a direct bearing on what is becoming a regular procedure in cases where a railroad, a trolley line, or a pipe line wishes to cross the line of a road already built. Such an attempt so often results in a pitched battle between gangs of men more or less completely armed as to suggest the idea that the companies do not think that any procedure authorized by law is sufficient to protect their rights. If the law is really inadequate in such matters it should of course be made adequate, but whether it is or can be made so or not, it ought to be, or to be made adequate for the punishment of every man who takes part in or is responsible for such lawless proceedings as have recently been seen in New Jersey, and at different times previously in other States.

The Pennsylvania, and the Delaware & Lackawanna roads have both taken the law into their own hands recently to prevent the crossing of their lines, the one by another road, and the other by a pipe line. It should be thoroughly understood that this is none the less anarchy, and no less an offense and injury to every citizen of this country because engaged in by wealthy corporations contending for what they conceive to be their rights, and to protect the interests of their stockholders. Most of those who do the actual fighting are poor men with whom it is something of a struggle to merely support life in themselves and families. In case they should consider it necessary to strike in order to maintain a living wage, and should then engage in anything resembling the recent operations, we should hear the representatives and the mouthpieces of the roads declaiming loudly against such violence, and demanding that the entire power of the State and even of the Federal Government should at once be exerted to put down the mob. They would at once declare that no matter what the cause nor what the merits of the original dispute, nothing else could possibly be done until mob violence was entirely suppressed, and for any damage they might sustain they would expect, and would probably obtain full compensation from the county in which the injury was done. Is this consistent? It seems to us that it cannot possibly be so regarded, but that on the contrary it is in every way inconsistent and disgraceful.

We do not believe in mob violence nor in anarchy. We believe that law enacted by and in the interest of the people should be supreme, and should be respected by all good citizens. When it is violated and utterly disregarded the culprit should be taught by suitable penalties that society must protect itself. But the punishment must be just as severe for a railroad officer as for a railroad laborer.

We give up the space in this issue that would otherwise have been occupied by the sixth article on "Bicycle Tools" to a description of a motor which seems to possess many qualities that make it peculiarly well fitted as a motor for road vehicles, including the bicycle. The fact that it works well and gives very high economy without the use of a water jacket is important, and the reduction of weight to about 3¾ pounds per horse-power would seem to leave very little margin for further reductions, and, in fact, very little to be desired.

So far as we can judge from our present knowledge of the engine, it bids fair to take a prominent place in the development of what we beheve is destined to become an important industry, *i. e.*, the construction of vehicles to be driven over highways by other motive power than the horse.

Literary Notes.

COMPRESSED AIR. Practical Information upon Air Compression and the Transmission and Application of Compressed Air. By Frank Richards, Mem. A. S. M. E.

This is a book of 203 pages, devoted to the exposition of what its author conceives to be the leading facts regarding the subject—those facts which the man who has to deal with compressed air or with the machinery for producing or utilizing it should be familiar with.

In his preface he says, "I would gladly do what I can to extend the field of its [compressed air's] usefulness, and I have so much faith in its powers that I believe that the best of all ways to advertise it is simply to tell the straight truth about it, and that I have tried to do."

But when writing on such a subject and endeavoring to "tell the straight truth about it," one must have something besides the desire or disposition to tell the truth; he must be thoroughly and practically acquainted with his subject. Such an acquaintance Mr. Richards has acquired, both by much study of the subject and by practical experience in the construction and management of machines for compressing air, and for using it. At the same time his book clearly shows that it is written without prejudice, and in the interest of its readers. He shows clearly the underlying fallacy embodied in some of the air-compressing machinery at present constructed, and it is likely that what he has to say regarding "Corliss Cross-Compound Condensing Compressors," two-stage compression, reheating, etc., will not be approved by some interested builders; but we believe he speaks the truth on these points; and no one who really does any thinking about the matter can doubt that, in the end, it will be better for all concerned that the truth should be proclaimed and known.

In this book, the bugbear of "freezing up" is fully and candidly treated, and one who familiarizes himself with this part of the subject will know how to easily avoid this difficulty. The author's name is familiar to our readers; he has produced a book that supplies an actual need, and one that will probably take its place as one of the most useful of standard authorities. Every man who has to do with air brakes, air hoists, or air machinery of any kind should have it; and any intelligent mechanic can easily read and make use of the information contained in it. It is published by John Wiley & Sons, New York. Price $1.50.

MODERN EXAMINATIONS OF STEAM ENGINEERS, or Practical Theory Explained and Illustrated. Written for Engineers by an Engineer. Comprising full and complete answers to 300 questions for the use of Engineers and Firemen, when preparing for examination, etc., etc. By W. H. Wakeman.

It seems best not to reproduce the title page of this book in full in order to reserve space for a word of comment. The name of the author will be recognized as that of a frequent and welcome contributor to our columns. We note also that Mr. Wakeman is "author of many editorials for mechanical publications," which doubtless accounts for much of the anonymous wisdom which glows upon the pages of our contemporaries. The title page of the book is per-

haps a litt'e misleading, in that it may give an impression that it is after the fashion of the numerous "catechisms" that have appeared in connection with steam and the steam engine. The questions in this work appear nowhere but at the end of the book and form, in fact, a very complete and convenient index to it. They are first given in numerical order and are then placed alphabetically, the page of the text where the full answer may be found being given in every case. The fifty three chapters treat upon topics relating to the generation and application of steam in the boiler and steam engine upon which the engineer, and especially the stationary engineer, should be informed. Everything is evidently written by one who knows what he is talking about, and wishes to make it plain and clear to those who do not know it all. Not much is to be said of the orderly arrangement of the matter, as no system is to be discovered in it. We have an impression that steam begins at the boiler, and we believe that the study of steam should begin there. In this book we begin with lap and lead of valves, and we get to something about steam near the middle of the book. No space is wasted with any reference to such a trivial matter as latent heat, and it does not appear from the book that the duties of the engineer have anything to do with the lubrication of any part of the engine. Arithmetical rules and examples are frequent all through the book, and no mathematics higher than that of the common school is to be found in it.

American Publishing Company, Bridgeport, Conn. Price, $2.00.

A Fast Run.

We noted a fast run made on the New York Central road a short time ago, and on the 24th inst. a better run was made over the Lake Shore road from Chicago to Buffalo, the length of the run being 510 miles and the elapsed time 8 hours 1 minute, an average speed including stops of 63.5 miles per hour. Five different engines were used on different parts of the run, and the last run of 86 miles—from Erie to Buffalo—was made at the rate of 70.98 miles per hour.

160 new subscribers have been added to our subscription list during the week just closed. We are proud of this growth, which shows the increasing usefulness and influence of this paper, and we expect this growth to continue. Do you know our terms to club raisers? If not write for them.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(393) L. B., New York, sends us a theoretical combined diagram for a compound engine, in which the dividing line marking the boundary between the high-pressure and low-pressure theoretical diagram is represented by a straight line parallel to the atmospheric line, and asks: Can the point in which this straight line cuts the expansion curve be taken for the point of cut-off in the low-pressure cylinder? *A.*—No, for the simple reason that the dividing line between the low and high-pressure diagrams cannot be a straight line parallel to the atmospheric line. The graphical method of determining the point of cut-off in the low-pressure cylinder has been given in our issues of August 11, and September 1, 1892, to which we must refer you, as the treatment of this subject will require more space than we can spare in this department.

(394) B. W. C., Litchfield, Ill., writes: There is a party here who wishes a machine built to revolve at a rate of 15,000 revolutions per minute. Do you think such a speed is possible? The largest diameter of the revolving parts being 18 inches; and what would you consider the best method of driving the same? *A.*—We have seen spindles making 15,000 revolutions per minute, but the diameter of these is very small. The safe speed of the parts 18 inches diameter will depend on their form and the material of which they are. If made of cast-iron the required speed cannot be obtained; if made of a good quality of steel, and the revolving pieces are disks, they can be run at the required speed with safety. The spindles above referred to were driven by a belt. Spindles having a very high speed may be driven by three friction wheels bearing against the spindle.

(395) K., Denver, Col., writes: I have a special reamer to make which is to have 12 teeth. Each tooth has to be deeper than the preceding one until the seventh, which is to be the same depth as the first one, and so on, opposite teeth being the same depth, and the top of each tooth is to be the same width. Kindly explain how to set the milling machine to cut the reamer correctly. *A.*—The irregularity of spacing or "staggering" can be properly given on the B. & S. machine, or on any machine having a movable index plate, by making the regular movement for the given number of teeth by the regular index pin, and then moving the index plate back and forth to give the variation, cutting opposite teeth at one setting of the plate, so that the reamer can be calipered. That is to say, after the first cut is made turn the reamer half way round, and cut the opposite tooth; then move the index pin for the next tooth, but before cutting it move the plate in the opposite direction, say, three holes. Cut two more opposite teeth, and at the next indexing set the plate back two holes; at the next only one hole; and then commence moving it in the same direction as the index pin moves, thus constantly varying the real movement of the reamer, yet making the regular movement of the index pin each time. By using a pair of dividers or "morphodites" as a scratch gage, you can draw a line parallel with any cutting edge that has been already milled, which line will indicate the proper width of the "land" and show you how deep to sink the cutter into the work.

(396) J. S., Chicago, Ill., writes: Referring to your answer to Question 370 in your issue of October 10th, current volume, I would say that I am under the impression the same will not answer for all conditions. The valve spindle in all safety valves I have had to do with simply bears against the lever and is not connected in any other way. In such a case I believe that the weight of the valve and spindle should be deducted from the force acting on the valve, which in your example would be $847.2 - 5 = 842.2$ pounds, and this result will be the total pressure on the valve. But should the valve be connected to the lever by a good fitting pin, then I should do as you say, as is in this case the 5 pounds act as a force with a distance of 3½ inches from the fulcrum. Then we would have in the first example according to my opinion

$$3.5 \times (847.2 - 5) = W \times 38.5 + 15 \times 11.$$

Kindly inform me if I am wrong, and, if so, where. *A.*—Your method of computing the weight W at the end of the safety valve lever is perfectly correct, and if you had solved the equation as given by you, you would have obtained the same answer as we obtained; thus, taking your equation we have

$$3.5\,(847.2 - 5) = W \times 38.5 + 15 \times 11;$$

this is equal to

$$3.5 \times 842.2 = W \times 38.5 + 165,$$

transferring the 165 to the first member of the equation we have

$$3.5 \times 842.2 - 165 = W \times 38.5 = 2782.7 = W \times 38.5;$$

hence

$$W = \frac{2782.7}{38.5},$$

which is precisely the same result as we obtained. From the above it will be seen that the manner of connecting the spindle to the lever makes no difference, and you may compute the weight at the end of the lever by your method, or by the method given in our answer to Question 370, the result will be the same in every case. We believe our method is somewhat simpler and easier to remember, as throughout the whole operation we deal with the moment of forces and nothing else.

(397) A. J. W., Brooklyn, N. Y., writes: Kindly give a rule for estimating the thickness of a copper pipe of given diameter to withstand a given pressure. *A.*—Multiply the pressure in pounds per square inch by the inner radius of the pipe in inches, and divide the product by the safe working stress of the copper in pounds per square inch, the result will be the thickness in inches. In symbols we have

$$T = \frac{P \times R}{S} \qquad (1)$$

in which T = thickness in inches, P = internal pressure in pounds per square inch, R = inner radius of pipe in inches, and S = safe working stress per square inch of the copper. The working stress will depend on the kind of joint, thus, if the ultimate tensile stress is 30,000 pounds, and the pipe is a seamless drawn tube, then we may adopt a factor of safety of 4, which gives us for the safe working stress S, $\frac{30,000}{4} = 7,500$ pounds. If the pipe has a longitudinal lap joint, we may assume for approximate estimates, that about half the metal is punched away at the riveted joint, hence at the joint we should allow only 15,000 pounds per square inch, and then taking a factor of safety of 4, we have for the safe working stress $\frac{15,000}{4} = 3,750$ pounds per square inch. All rules or formulæ relating to the thickness, safe pressure, etc., of pipes or cylindrical shells can be derived from the following fundamental formula:

$$P \times R = T \times S \qquad (2)$$

in which the letters denote the same quantities as before. For instance, if in formula (2) the values of P, R and S are known, then we see at once that the thickness is equal to $T = \frac{P \times R}{S}$ as given in formula (1). If the values of T, S and R are known, then in accordance with formula (2) we have $P = \frac{T \times S}{R}$. In a similar way the numerical value of any one of the four quantities can be found from formula (2) without any other knowledge than that of simple arithmetic, when the other three quantities are given.

(398) J. J. B., St. Louis, writes: I have a straight cupola 30 inches shell (22 inches after lining) 3 tuyeres 3½ inches square, 10 inches above bottom of cupola. The door is 6 feet above bottom, stack 40 feet high, 15 inches inside. We have a Boston Forge Blower No. 7, or 35 inches, running about 2,800 revolutions per minute. On the bed is charged 250 pounds coke and 400 pounds pig-iron. As soon as this is burnt down below the door, we again charge 150 pounds coke and 300 pounds iron, using 10 per cent. limestone. In two or three such charges the cupola clogs about 6 inches above the tuyeres, and the bottom has to be dropped. I wish to run this cupola 5 or 6 hours, slagging every two hours through the tapping hole. Can this be done; if so, where is my trouble? *A.*—Mr. L. C. Jewett, of Boston, replies to this question as follows: "I do not believe an ordinary cupola with fan blast can run 5 or 6 hours, if only 22 inches diameter inside of lining, as the fuel will become spent around and in the vicinity of tuyeres, and cupola will bridge over just above the tuyeres, preventing the air from getting any farther, and as it is stated in foundry parlance, 'bung up.' The best plan to try on this cupola, is to put coke some 22 inches or 24 inches above the tuyeres. If 250 pounds does that, all right, but that is the point it should be charged to before iron is charged on. Then put on 3½ pounds of iron for each pound of coke in the bed, then 100 pounds of coke, or perhaps 75 pounds, and then 400 or 600 pounds of iron, and keep on, in alternate charges of coke and iron, reducing fuel, or increasing iron as the end of heat is reached, unless the cupola is being taxed beyond its legitimate capacity, when the reverse is to be done—lessen the charges of iron toward the end of heat. Slagging—slagging through the tap holes is an unpleasant way to do it, and likewise unnecessary. Make a hole in back of furnace shell, or in a place as much out of the way as possible. It should be certainly 3 inches below the tuyeres, and away from the tuyeres, that the blast may not blow on the slag and chill it. Make hole 3½ inches diameter. After being in blast ½ hour open slag hole, and let it remain open during the heat; if it closes up, open with dry pine stick or hot iron bar Do not use cold iron bar. But I never thought slagging a furnace less than 42 inches diameter inside lining amounted to much benefit. The tuyeres of this cupola are too low to use slag hole, or to melt for a long time. Ten inches above bottom leaves but little fuel below tuyere, and while the supposition is that it economizes fuel to have low tuyeres, the fact is that with tuyeres 18 inches, 20 inches, or even 24 inches above bottom heats can be continued longer, more iron can be charged on the first charge, and instead of saving at the spigot you save at the '*bung.*' Of course, the directions for charging given above are for trying it, and by watching the heat it will tell what changes may be necessary. If the iron comes hot and slow, then less fuel on the first charge might be tried; if melting proceeds slower and hotter, then it is evident that less fuel on the alternate charges can be used; but if iron comes dull, or at low temperature, then put more fuel on the bed and subsequent charges next time. It is one of those things that require a little attention with every cupola; and situations, size of pipes, pressure of blast, kind of stock, iron and fuel, way fire is started, and condition before charging, how cupola is daubed up, how long fire is kindled before blast goes on, and an endless amount of straws, if observed, will tell one the way the wind does and should blow."

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 872.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patent Solicitor. J. G. D. Mack, Madison, Wis.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engrs. should investigate the Korting Condenser. Obtain Catalog from A. Aller, 109 Liberty St., N. Y.

Marine Iron Works, Chicago, builders of steam yachts and marine machinery; catalogs free.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

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Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

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Force, Energy and Power—III.

By P. LOBBEN.

POWER OF DROP HAMMERS—RUNNING DROP HAMMERS.

There is another quantity which is used in dynamical calculations, and that is the product of the mass of the body and its velocity in feet per second. This product is called the "momentum" or sometimes the "quantity of motion," or sometimes it is transposed with another quantity of exactly the same numerical value and called "time effect." But, no matter what we call it, it originated from the same natural law, that when a pound of force acts upon a pound of matter during one second, and this pound of matter has no resistance but its inertia, it will move through a space of practically 16 feet, and it will at the end of the second have acquired a velocity of 32 feet per second. For convenience let us in this article denote this "time effect" by the letter q, and expressing this quantity of motion in algebraic form we have:

$q = M\,V$.

q = quantity of motion, momentum or time effect.

V = velocity in feet per second.

M = mass of the moving body.

The mass is practically $\frac{1}{32}$ of the weight of the body on the earth's surface, when we are using the feet and pounds as units. In the previous articles it was explained that if a pound of matter is acted upon by a pound of force in one second, it has at the end of the second a velocity of 32 feet per second. Thus we see q will be $\frac{1}{32} \times 32$ which equals 1, but if we increase the moving weight to two pounds and keep one pound of force to act against its inertia the velocity will at the end of the first second be only 16 feet per second, but the mass of the moving body will be increased from $\frac{1}{32}$ to $\frac{2}{32} = \frac{1}{16}$, and the quantity of motion will still be $q = \frac{1}{16} \times 16 = 1$.

Thus the result of one pound of force acting for one second against the inertia of any body which is free to move is always unit for quantity of motion.

This expression for quantity of motion is used very frequently in dynamical calculations, and most of the readers of the AMERICAN MACHINIST, of course, are very familiar with it, and this is nothing new to them, but there is an army of ambitious young mechanics who have not yet got so far along

that they see through these things, and it is the hope that these plain writings on the subject will throw some light upon them, and in time help to make things greatly interesting which look dry on the surface.

Suppose a body free to move and weighing 1,280 pounds is acted upon during three seconds by a force of 400 pounds, what is the quantity of motion?

$$\text{Mass of body} = \frac{1,280}{32} = 40.$$

The velocity of the body we may obtain from our fundamental rule explained in March 14th.

One pound of force acting on one pound of matter, not interfered with by any frictional resistance, when acting one second produces a velocity of 32 feet per second. The velocity increases directly as the time increases and directly as the force increases, but it decreases as the weight of the moving body is increased. Thus the velocity of this body must be

$$V = 32\,\frac{3 \times 400 \times 1}{1 \times 1 \times 1,280} = 30, \text{ and}$$

$$q = 40 \times 30 = 1,200.$$

Thus the quantity of motion is 1,200. This must not be mixed up with kinetic energy, which is the product of the force and the space through which it acts, but q is in numerical value equal to the product of the force and the number of seconds in which it acts. Thus there is, when we see through the problem, no need of all the figuring in above example.

q is equal to 3 seconds multiplied by 400 pounds = 1,200.

Hence the word "time effect" is sometimes used in expressing this quantity. If this moving body is brought to rest again in three seconds it will exert an average force of 400 pounds, but if it is brought to rest in half the time it will exert double the force. Thus it would be possible to increase the force to any magnitude, and make it infinitely large, if we could decrease the time of action to an indefinitely short period. For instance, if a drop hammer weighs 800 pounds and falls 4 feet the time effect is

$$q = \frac{800}{32} \times \sqrt{4 \times 64} = \frac{800 \times 16}{32} = 400.$$

This is the product of the mass and the velocity, because mass is weight divided by 32, and velocity in a falling body is the square root of the product when the hight of the fall is multiplied by two times acceleration due to gravity. But this is in numerical value also, as we will see, equal to the product of the time and the force. What time does it take for a body to drop four feet?

$$\text{Time} = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 4}{32}} = \sqrt{\frac{1}{4}} = \frac{1}{2} \text{ second,}$$

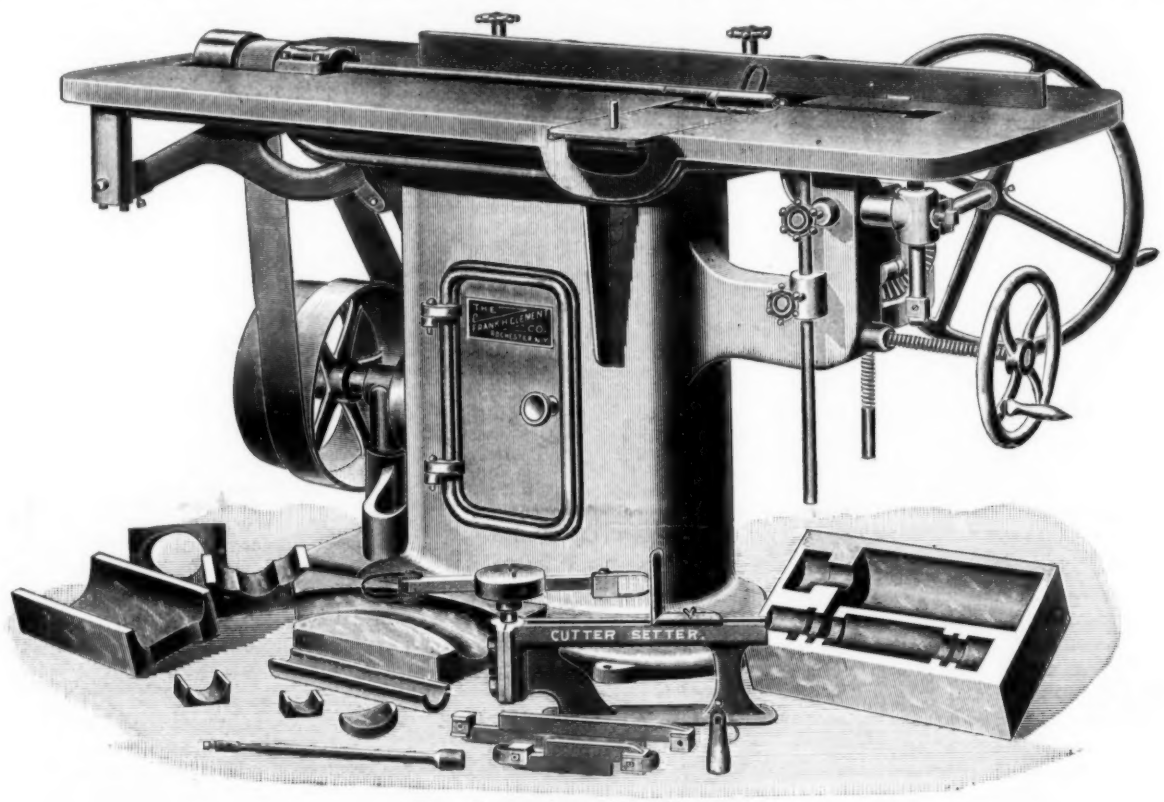
and the force in a falling body, of course, is equal to its weight; thus we have:

$$q = 800 \times \tfrac{1}{2} = 400.$$

In these calculations all frictional resistance is set out of question, as this is only to explain the principle, but in practical calculations in all kinds of machinery friction is a great factor that must not be neglected.

Suppose, now, that the hot iron on the anvil is compressed $\frac{1}{2}$ inch by the hammer, it is then fair to consider the duration of the blow must be $\frac{1}{2} \times \frac{1}{24} = \frac{1}{192}$ second, because when the hammer strikes the anvil its velocity will be $\sqrt{4 \times 64} = 16$ feet per second, and that will be the initial velocity when the hammer begins to compress the iron; but the average velocity during the blow must be only half of the initial velocity, or 8 feet per second, and the distance it works through is $\frac{1}{2}$ inch $= \frac{1}{24}$ of a foot, therefore the duration of the blow must be $\frac{1}{24}$ divided by $8 = \frac{1}{192}$ second, and the average pressure will be $400 \times 192 = 76,800$ pounds.

If the material had been harder, the duration of the blow would have been shorter and the force more intense. If, for instance, the blow had lasted half as long a time the average force would have been twice as much, etc. In the same way the same laws hold good for any moving body when brought to rest, but not only that, it is the same in starting a body into motion, the shorter the time in which a body is set in motion the more force must be expended. For instance, look at a locomotive when it starts a heavy train at a railroad station, the wheels are spinning around and slipping on the rails and it seems almost impossible that it could pull its train, but after the heavy mass is started it walks along with apparent ease, even up considerable grades. When looking around a little and thinking these principles over, it is wonderful how many things in daily life illustrate this great natural law of dynamics. But to return to the drop hammer, it is stated that it falls 4 feet and weighs 800 pounds; the kinetic energy is therefore $800 \times 4 = 3,200$ foot-pounds, and this energy is expended at the anvil in compressing the iron one-half of an inch or $\frac{1}{24}$ foot; the average force must be 3,200 divided by $\frac{1}{24}$, which is $3,200 \times 24 = 76,800$ pounds, exactly the same as when figured by the time effect. How much power does it take to lift this hammer? Measuring the diameter of the rolls between which the drop-hammer board is placed, we find it to be 10 inches. The revolutions are 100 per minute; thus the surface of the roll is traveling at a rate of $\frac{100 \times 10 \times 3.1416}{12}$ = 261.8 feet per minute. The weight of the hammer is 800 pounds, and the power expended in lifting 800 pounds at a rate of 261.8 feet per minute is $261.8 \times 800 = 209,440$ foot-pounds per minute. Thirty-three thousand foot-pounds per minute is a horse-power, therefore this hammer when moving at a uniform speed with the rolls is consuming $\frac{209,440}{33,000} = 6.35$ horse-power. Adding some for friction, we may call it eight horse-power. How wide belts are required? The driving pulleys are 32 inches diameter, and using good single leather belts and not much difference between the size of the driven and the driving pulleys, we probably figure by the rule often used for small belts that a belt running at 1,000 feet per minute will transmit one horse-power per inch of width. The speed of these belts is $\frac{100 \times 32 \times 3.1416}{12}$ = 838 feet per minute. There is one belt driving each roll, so one belt only needs to carry four horse-power. According to this the belt would be $\frac{1,000 \times 4}{838} = 4.76$ inches; better put on 5-inch belts, as, to the practical eye of the machinist, this looks to be as narrow a belt as it is reasonable to use. Besides that, these pulleys on the drop hammer are pretty wide, in fact, wide enough for 6-inch belts. The 5-inch, anyhow, is according to figures; why should they not work? They do work. But how? After a little while they are getting slack. Well, new belts always stretch, you know. Cut them off and get them tight enough—yes, tight as a drum. There is a new trouble; this board is wearing out right down in the place where the rolls are taking hold when the hammer is starting on its upward journey. That hammer also takes so hard on the main line that by the jerks in the main belt every stroke of the hammer may be counted. This does not look very well; it must certainly take more than eight horse-power to lift this hammer. There is something left out in the calculation, and that is the inertia of the hammer head and die. When the blow is expended on a big hot iron so that the dies do not come together and help to rebound the hammer head upwards, a tremendous force is required to bring this 800 pounds of matter up to speed at the moment the rolls are let together, and the shorter the time in which the speed is acquired, the more force it will take. If we knew what net force (after all losses were deducted) was acting to overcome the inertia of the hammer, the time elapsed from when the rolls commenced to act and until the hammer got up to speed with the rolls, might be calculated; but having no facts to base calculations upon, such an attempt would be useless. It is enough to know that it is impossible to start the hammer head instantaneously, it must have some time—no matter how small—in which to get up to the speed of the rolls, and as the belts are tightened to their utmost, so that they do not slip much on the pulleys, hence the grinding away of the drop-hammer board just in the place where the rolls are taking hold when the hammer head starts its upward motion. This may suggest that there must be bother, either with slack belts or else with the wearing of the board. No, not at all. There is a fine way to avoid the most, if not all of this trouble, by putting on good double belts, better have them six inches wide and run them not too tight or, better still, run them as slack as possible to run nicely, and there is not the least trouble with the wearing out of the drop-hammer board and getting a big hollow into it where the rolls are taking hold in starting the hammer. The rolls grasp firmly, the belts yield and slack up the speed—just a moment—the hammer and board goes gently with the rolls, the whole thing works like a charm. To make things still more smooth, a fly wheel on the main line is a good thing, and if the source of power is small such a fly wheel will be appreciated. Why not have heavy pulleys on the drop hammer and let them serve as fly wheels? No, this would then cause the same trouble as the small overstrained belts. It is this yielding quality with belts, if taken the right advantages of, that makes the success of lots of machinery. By using a fly wheel to equalize the power it will not take eight horse-power to run a drop hammer, as it is only at short intervals that the power is needed. This drop-hammer problem shows how important it sometimes is in practical work to take into consideration that there is no comparison between the power required to keep a moving body in motion and the power required to start it quickly. The above rule for figuring belting would give ample driving power if more than eight horse-power were not required at the moment the hammer started upon its upward movement. It is also a good point not to run drop hammers too fast, as the time gained in fast running is usually lost many times over in breakages in bolts and screws. When the hammer has gained its full speed upwards it strikes against the dog with a tremendous force, and if the hammer is to stop its motion in a given distance after striking the dog this force will increase as the square of the velocity. Therefore slower speed may sometimes prevent breaking of bolts and screws to a great extent. It may look like going backwards to talk of reducing speed in this rushing age, but a little figuring will show that what may look as a loss is a gain. Suppose a man forges 1,000 pieces in a day, and each piece receives five blows from the hammer, and that the hammer is falling four feet each blow, then all the upward movements added together would make $5 \times 1,000 \times 4 = 20,000$ feet; if then the hammer is traveling upwards at a rate of 261.8 feet per minute, all the time used for upward movements would be not quite 80 minutes of the whole day in forging 1,000 pieces taking 5 blows each, or in forging 5,000 pieces taking 1 blow each. Allowing that considerably more time is consumed on account of this explained slacking of belts and lost motion, we may say even twice that time is used, or 160 minutes. What would it then amount to if 5 per cent. of that speed was sacrificed? Less than 10 minutes in a day, and what if this could save breaking bolts, loosening dogs, snapping off screw heads, etc., and probably also save the good and jolly feelings of the man running the machine; in short, change things from bothersome to pleasant? Although this speed mentioned works very satisfactorily for drop hammers, if they are placed on good foundations, poor overstrained belts, fast speed, and poor foundations will cause lots of trouble in the practical results with drop hammers.



THE CRANE CORE BOX MACHINE.

The Crane Core Box Machine.

We illustrate on this page a machine for making core boxes, the range of its productions being well indicated by the specimens of its work shown upon the floor.

There is a steel spindle which is provided,

near the driving pulley, with a box of ordinary construction, and near the end which carries the cutters, with a strap box, *i. e.*, a box the upper part of which consists of a thin strap or piece of sheet metal, this being necessary in order not to interfere with the work.

The nature of the cutters used is shown by one which is seen in the spindle, and by a larger pair of them which is seen in a head placed in the device for setting cutters shown in the foreground.

The table is moved vertically by the large hand wheel shown to give the required depth of cut, and the work is then fed along the guide shown, which, of course, is adjustable to any required distance from the spindle.

A slide is fitted to the table which can be withdrawn when cutters of unusual diameter are to be used, and there is provision also for an extension spindle of smaller diameter, the opening in the table for this being shown, and the spindle itself upon the floor.

The machine will cut a semicircular core box from ¾ inch to 20 inches diameter and of any length from solid or glued stock, and can do a considerable variety of work upon patterns which consists of the production of concave surfaces.

The frame of the machine is a single casting, and the countershaft shown at the end is made adjustable, so that the proper tension can be maintained on the belt, which should be endless. The machine occupies a floor space 56 inches by 36 inches, and is made by The Frank H. Clement Co., Rochester, N. Y.

Hydraulic Beam-Punching Machine.

We present herewith engraving of a portable hydraulic machine for punching holes in steel beams. It has a capacity to punch a 1-inch hole in 1-inch steel, and by using two removable jaws can punch holes up to the limit of its capacity within ¾ inch of the front of the machine.

The jaw shown on the machine is for web punching, and the jaw shown loose holds a large flat die beveled on one side, which is under cut to allow I-beams as small as 4 inches to be punched on the flange. The swivel wheel has been put at the back of the tool as more out of the way with large work.

Provision is made for quick lowering of the ram, all parts are made easily accessible, and the head is made rotative with a guided plunger.

The depth of jaw is 12½ inches, hight 13 inches, and weight of machine 1,450 pounds. It is made by The W. & S. Hydraulic Machinery Works 204, East Forty-third street, New York.

Emery Grinder.

The accompanying cut is of a grinder which is intended for such general grinding as is usually done on such machines, its special features being in the arrangement of the attachments shown.

The surface grinding table is supported upon a substantial turned column which can be adjusted vertically by the hand wheel and screw shown, and can be clamped rigidly to any hight.

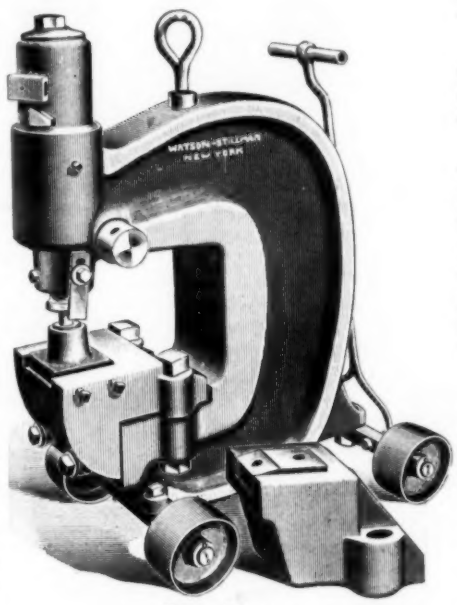
The hood of the water attachment almost covers the wheel, and at the bottom there is a tube by which the water runs into a pot from which it can be drained off. Both attachments are readily removed from the machine when it is desired to use it without them. The water attachment takes a wheel 12 inches by 1½ inches. The machine is manufactured by Perry Ransom, Oshkosh, Wis.

The World's Injustice to the Technical Man.

On October 5th the Technical Society of the Pacific Coast held an "informal" meeting which comprised a dinner at the *Maison Riche*, San Francisco, an address by the president of the society, Mr. George W. Dickie, Manager of the Union Iron Works, and a lively discussion thereupon. By the kindness of our esteemed correspondent, Mr. John Richards, we are enabled to reproduce the principal portion of Mr. Dickie's address, which we know that our readers will appreciate.

Mr. Dickie said in part as follows:

"The world has decreed that the investigations into and the manifestations of natural phenomena should be divided into two classes, that of the scientific and the technical. A simple definition of these two



BEAM-PUNCH.

classes would be, that those investigations that are of no immediate use are scientific, while those that have an immediate application to some industry, or that satisfy some want, are technical. I believe that all knowledge that lies within the power of man to acquire will some day be useful in supplying some want of his; but at present much scientific knowledge that has been acquired appears to have no connection with our physical advancement.

"Is it not curious that the world should honor those men most whose life-work has no bearing whatever on man's physical requirements, or the extent of his resources, and has but little admiration for those whose lives have been spent in devising means whereby the burdens of humanity are lightened? The world places the philosopher in the top row of the scientific benches, while the mechanic is relegated to the lowest forms in the technical class. He who stumbles upon or discovers a new element in some of nature's laws, stands infinitely higher in the eyes of the world than the mechanic whose labor has produced work that has lightened the labors of millions of his fellowmen.

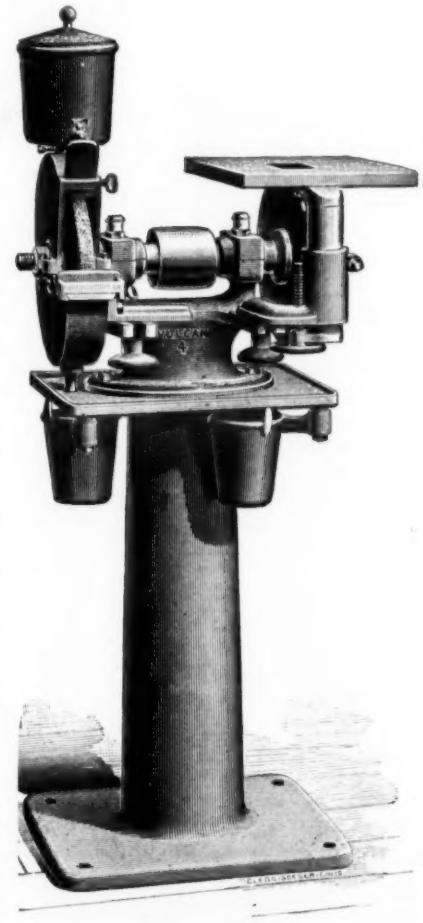
"I think this may be taken as a strong proof of the inherent intellectuality of men. Yet, when we consider the fact that the greater part of the world labors under the constant and unavoidable necessity of providing itself with daily bread, and never loses an opportunity to protest against the imposition, it would seem that one who seeks to relieve the burden of toil by the invention of labor-saving implements, would gain the gratitude of his fellow-men. Yet, I do not know that the technical man deserves any better fate than has befallen him His ambition is of the earth, earthy. He deals with 'things' instead of with 'ideas,' and therefore gets his reward from things, and not from men. His days are passed in close offices or dreary workshops. He has no delight in nature, except so far as she will help him to turn his wheels. He concentrates his whole being within some little trade circle. From dawn to dark the technical man lives and moves, and has his being in iron, steel, wood, leather, or whatever other thing he makes or vends, and he often carries these things to his home, to make a technical shop of that sanctuary; tries to make a reputation by discussing them at the Technical Society with other technical people, and is sadly disappointed when the world takes no notice of him. And yet the world knows full well that there is but one possible source of relief for the burden of toil that afflicts humanity. This lies in the improvement and development of the industrial arts, the end and object of all technical effort.

"The better conditions of life that now exist, as compared with those of a century ago, are due almost entirely to the labors of technical men. Something has been done by the philosopher, something has been done by the statesman, and something has been done by the humanitarian. But what could all their efforts have accomplished without the mechanic?

"I have often been surprised that so few of the general public possess any knowledge of the men to whom the honor is due for the bettered conditions of life we enjoy.

"The ladies of society are considered wanting in culture who have no knowledge of those who by their writings add to the means of mental pleasures and accomplishments; but can one of them in a thousand tell to whom we owe the spinning jenny or the power mule? Yet these inventions have made it possible for them to have the time for mental enjoyments.

"If the question be asked in a miscellaneous collection of educated men, 'who invented the locomotive?' it is almost certain that George Stephenson would be the name given, and doubt would be expressed if any one should explain that he only added a little to the labors of others in the same field. Yet amongst that same collection of men it would be considered a sign of want of education and culture not to be acquainted with the works of Kepler, Bacon, Newton, Davy, Faraday, Darwin and many others that have contributed to the sum of human knowledge, but whose work, at least at the



EMERY GRINDER.

time it was done, had but little promise of material help for humanity.

"The world is not entirely without gratitude, only the technical man is disappointed because he cannot buy its admiration by material benefits. A man may labor hard and wear his life out to feed and clothe his children comfortably, but if he forgets that they have hopes and fears, passions and emotions, when the earth closes over him, he will soon be forgotten. While the man that has a soft heart for their sorrows, and sings a song for their joys, lives long in loving memory, even though he was careless about their comfort, and though his song singing may have involved them in empty stomachs and bare backs.

"Where intellectual and moral emotions are possible, bodily comforts, difficult as they are to obtain for the majority of mankind, seem small by comparison, at least when they are actually enjoyed. Food and money appear the greatest possible blessings to the hungry and poor, but when once a good lining has been secured for the stomach and pocket, it is difficult to recall the cravings of the past, or exhibit the gratitude we expected to feel for those who made it possible for us to get into so comfortable a condition.

"Communities as a whole are very much like the individual in this respect. They soon forget those whose labors bestow upon them the power to do with little effort on their part what it took their fathers much time and toil to accomplish, while they reverence those who furnish them with some new mental pleasure. Who knows anything about Fairbairn, the millwright, and who does not know something about Shakespeare, the playwright?

"Outside of engineering circles James Watt is little more than a name with nothing about it to inspire admiration, and if he had not had the good fortune to be a Scotchman, and thus become the object of a clannish admiration, he would be as nearly forgotten now as the Welshman Trevithick. Yet every man, woman and child of this and the last generation in the civilized world is the better for his inventions. Take a contemporary name of Watt's, that of Burns, and we find it known and admired wherever the English tongue is spoken, and far beyond that limit. He provided nothing new to help widen the scope of intellectual vision; the things he sang about were in the field and in the town, full in the sight of all, and only became bright from the charm and beauty of his setting. Yet, when touched by his inspiration they became a treasured possession of mankind, never to be abandoned or forgotten until human nature changes, of which there are no signs. The magnificent benefits that have resulted from Watt's inventions being material, do not touch the heart of mankind, and therein lies the difference.

"The difference between the scientific and the technical is, however, much smaller than that between the poet and the mechanic. The purpose of the man of science is to search out the meaning of that great universe of which he himself is a part, while the technical man labors to turn scientific knowledge to some useful purpose. They are but two links of the same chain, sometimes these links are far apart, and often they are found close together, but always of the same material.

"Faraday laboring to deduce the laws of electro-magnetic induction is very close to Wheatstone or Siemens laboring to produce a practical dynamo, only the one worked at the Royal Institution for the advancement of science, while the other labored in a workshop.

"The astronomer computing the orbit of a planet is doing the same work as the engineer computing the orbit of a centrifugal governor, only this difference, that the astronomer may make a mistake, but the planet rolls on as it ever has done. If the engineer blunders, his whole work may be rejected, and his work be thrown useless on his hands. How would a blundering astronomer feel if on account of his mistake in fixing the orbits of the planets the whole planetary system should be thrown on his hands?

"Regnault's researches into the properties of steam are not more important than the experiments of the engine builder, who embodies their results in a motor of surpassing economy. Lord Kelvin is not greater when he is investigating the physical condition of a wether than when he is quadruplexing an Atlantic cable. Nevertheless, the world has made up its mind that useful practical knowledge stands on a lower footing than that to which no suspicion of utility can attach. It will not consider if there be any difference in the intellectual power required to produce the result.

"The moment the world sees commercial bearing in any study it puts that and its author once and forever in a secondary position, and feels relieved of all obligation to or

recognition of him. His discovery may have been the result of long and deep thought, and the research of a lifetime may have been expended in its development. But it is technical, and therefore has no claim on man's admiration. This is true, but on behalf of my technical brothers I claim that it is not right. Undoubtedly, mind is above matter or force, and life is more than meat. Yet there need not necessarily be anything debasing about that which makes meat more easily obtained for the bulk of hungry mankind. If the thing to be accomplished requires the application of the highest quality of mind for its solution, it is none the less intellectual because its accomplishment simplifies the struggle for daily bread.

"Let me say to our scientific and philosophical friends, who have honored us with their presence to-night, that we do not begrudge you all the honor and admiration the world can bestow, and we would not have you deprived of one ray of glory, while claiming that a little beam of recognition might occasionally lighten the gloom of the technical man's existence.

"The technical man himself is, in my opinion, to a large extent responsible for the slight regard in which he is held by the world at large. His work is not generally understood, and he is usually very proud and cares not what the world may think of him. He starts out with the idea that he can feed his soul on iron filings and sal ammoniac, and be satisfied. And when his nature has been all cemented into a sort of 'metallic' conglomeration, he wonders why the world will not worship this iron image of a man.

"Our materialism and our utilitarianism is just what the world doesn't like about us. If we are ever to be anything else than hewers of wood and drawers of water to the people, we must touch them in more sensitive points than we have hitherto been hammering at. Let us put some mind as well as matter into our work. Let us clothe our technical things so that they will be received in good society.

"When the technical man can write a specification that the reading of will give mental pleasure to him or her who knows nothing about the thing specified, he will have his reward. Why can't he build up the various parts of the engine as he proceeds with the specification narrative, bringing crosshead and connecting rods, crank pin and journal, together, setting the various characters into bold relief, each member of the group, working the reader up to the grand consummation when steam enters into the throbbing heart of the assembled parts, and the romance concludes with a wish on the part of the author and reader that nothing in the future life of the various characters thus assembled may cause them to part? We ignore what the world needs and must have, and expect that the world will honor us for so doing. The world will pay us just what it is worth for its food and clothing, that is, we will be allowed food and clothing like the rest, but if we want to be praised and admired for our work, that work must touch the great sensitive heart of humanity."

If you feel within yourself a desire to expand your usefulness in behalf of the machine interest of this country; if you are a bright, aggressive man who can tell his story to advantage and address business men; in short, if you think it possible to earn more money, write or call on the Treasurer of the AMERICAN MACHINIST, and he will show and explain a method which might make you a more useful man and add largely to your income.

It is probable that a number of copies of the AMERICAN MACHINIST were lost in the wreck which occurred on the Pennsylvania Railroad recently, and any of our subscribers who missed their papers of the 25th can have them supplied on application to this office.

MANUFACTURES

The Eastern Mfg. Co., of South Brewer, Me., will shortly erect a new paper-mill.

J. W. Boyers is organizing a company at Sistersville, W. Va., to erect wire nail works.

The Knight Cycle Company, of St. Louis, Mo., has been formed with a capital of $30,000.

The Co-operative Town Company, of Elizabethtown, Tenn., propose to erect a steel plant at that place.

The Turner Tobacco Granulating Machine Co., of Roanoke, Va., has been incorporated by Geo. A. Turner and Wm. J. Wright.

The Bradley & Hubbard Mfg. Co., of Meriden, Conn., is adding a blacksmith shop, and making other improvements to its plant.

The E. E. Hilliard Co., of Buckland, Conn., is erecting an addition to its plant, and will shortly put in carding and spinning machinery.

The Tyger River Mfg. Co. has been incorporated by G. S. Coffin and others to erect a cotton-mill at High Shoals, near Woodruff, S. C., with a capital of $200,000.

The large plant of Bradley & Co., at Syracuse, has been sold to the Syracuse Cycle Co., and will be equipped with machinery for the manufacture of bicycles.

The Homestead Mfg. Co., has been organized, and is re-arranging and fitting up at Homestead, Pa., a manufactory 40x100 feet, two stories high, for the manufacture of an improved straightway valve. Mr. F. Schuchman is president of the company, and Mr. Wm. F. Harrison is superintendent.

The Wilbraham-Baker Blower Co., of Philadelphia, Pa., have placed the order for their new pattern storehouse with the Berlin Iron Bridge Co., of East Berlin, Conn. The building will be 64 feet wide and 86 feet long, one story high, with brick side walls, covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof covering, and will be absolutely fire-proof. The Wilbraham-Baker Blower Co. report trade as very brisk, and are full of business in all departments.

The Betts Machine Company, of Wilmington, Del., inform us that they are shipping a ten-foot boring and turning mill to parties in London, England, and that this is the second mill of this kind they have sent to the same concern within a year.

The Lunkenheimer Co., of Cincinnati, Ohio, have brought out a fine card, illustrating their improved regrinding Globe valve. It is made to hang upon the walls of an engine room or shop, and the company informs us that they will send it to any address upon application.

The Globe Machinery Company, of Chicago, successors to the Benjamin Machine Co., have increased their capital to $75,000, full paid. Mr. Martin is manager of the new company, and reports a most gratifying condition of business. It was deemed advisable to rechristen the company upon the retirement of Mr. Benjamin.

The King-O'Hara Mfg. Co., of Chicago, have incorporated under the laws of the State of Illinois for the purpose of carrying on a general manufacturing business in the line of special machinery. Their shop has been equipped with the latest improved tools, and will be under the personal supervision of Mr. P. F. King. One of the chief products will be a patented bicycle saddle embodying entirely new features of adjustment.

The Link-Belt Machinery Co., of Chicago, Ill., have recently put in for the Essen Coal Co., Federal, Pa., what is said to be the most extensive electric coal-mining plant in the world, the equip-

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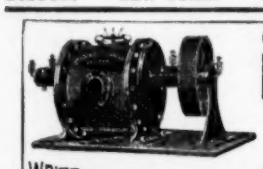

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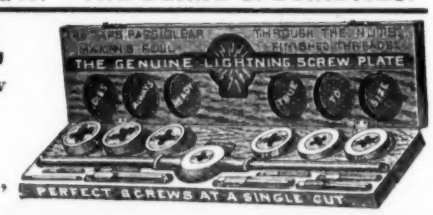

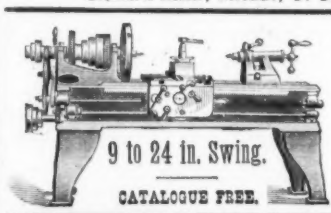

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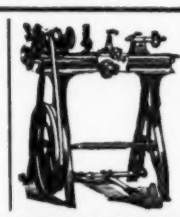

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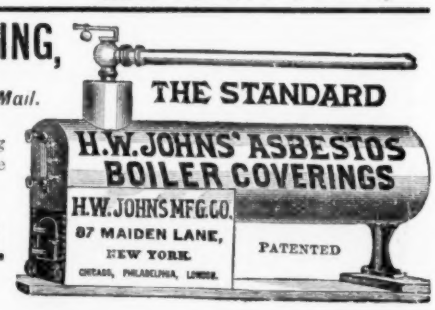

ment consisting of 16 "Independent" chain breast mining machines, two 80 horse-power "Independent" 4-wheel locomotives, three 150 K. W. "Independent" mine type dynamos, 600 horse-power Russell steam plant, 22 miles copper wire, the necessary switchboards, trolley supports, arc and incandescent lamps.

Machinists' Supplies and Iron.

NEW YORK, November 2, 1895.

Iron—American Pig—We quote standard Northern brands, $13.75 to $14.50 for No. 1; $12.75 to $13.50 for No. 2; $12.50 to $13 for No. 2 Plain, and $12.50 to $13 for Gray Forge. Southern brands, $14 for No. 1; $13.50 to $13.75 for No. 2; $13 to $13.50 for No. 3; $13.50 to $14 for No. 1 soft. $13 to $13.50 for No. 2 soft; and $12.50 to $12.75 for Foundry No. 4.

Antimony—The market is rather weak. Cookson's is quoted at 7¾c. to 8c.; Hallett's at 7c. to 7¼c., and Japanese at 6¾c.

Lard Oil—Prime City is quoted at 50c. to 51c.

Copper—The market is weak and unsettled. Lake Copper can be obtained at 11¾c., and probably a shade less. Casting Copper is held at 11c. to 11¼c.

Lead—The market is more active at lower prices. Sales have been made at 3.30c. to 3.32½c.

Spelter—The market is weak and prices are lower. For New York delivery, 3.90c. to 4c., according to quality is asked.

Tin—The market is fairly active, with prices at 14.70c. net cash in lots of 5 tons or more.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Practical mechanical draftsman desires position New York City preferable. K., AM. MACHINIST.

Wanted—Pos. as foreman, job, or mfg. by mach't of 30, with chance to grow up. Box 153, AM. MACH.

Wanted—By a thorough practical man who is competent, reliable and strictly temperate, a situation as foreman of foundry. Box 154, AM. MACH.

Situation wanted by mechanical draftsman; experienced in construction of gas apparatus and general machinery. E. Z., care of AM. MACHINIST.

Patternmaker, aged 23, wants position in Ohio or adjoining State; 4 years' experience in wood patternmaking. Box 152, AMERICAN MACHINIST.

Wanted—Position as foreman. Eight years in charge of machine-tool work. References. Age, 33. Address Box 148, AMERICAN MACHINIST.

Wanted—A traveling salesman to handle small machinists' tools, such as reamers and gages; state salary; none but experienced man with satisfactory reference need answer. Box 151, AM. MACH.

Responsible position wanted by practical mechanic and draftsman. Had considerable exp. in designing tools and mach., and held pos. as chief draftsman and assistant supt. A. B., AM. MACH.

Machinist and engineer familiar with best machine, boiler shop and foundry practice, wishes to make a change; competent to take entire charge of works or of engineering & estimat'g departments; capable manager & salesman. M., AM. MACHINIST.

I would like to correspond with parties desiring the services of an experienced foundry foreman or superintendent understanding the foundry in all its details. Engine, machinery or electrical work preferred. Address "Loam," AMERICAN MACHINIST.

Wanted—Foundry foreman; one who can work 100 men if necessary, on general machinery castings. One who understands melting and mixing, and can produce *best quality* work at a reasonable cost. No experimenter need apply. Permanent position and good wages. Coke, AM. MACHINIST.

Wanted—An intelligent man in every machine shop in New England to utilize his spare time in raising clubs of subscribers for the AMERICAN MACHINIST; liberal commission. Address, with references, John A. Walker, N. E. Agent, No. 4 Church Street, Dorchester, Mass.

Wanted—A first-class draftsman. Would prefer one who is a practical machinist and who has had large experience in designing and constructing coal mine equipments, such as hoisting and haulage engines, ventilating fans, revolving and shaker

(*Continued on Page* 894.)

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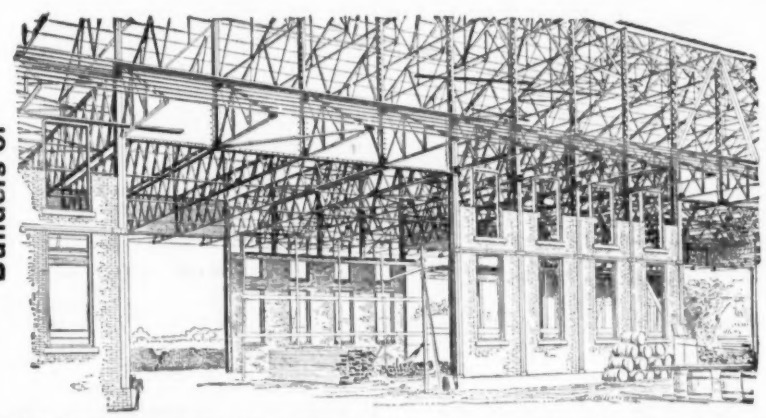

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The above illustration is taken direct from a photograph, made during the construction, and shows the details of an Iron Building designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 60 feet in width by 320 feet in length, and is two stories high—the lower floor being used as a Ship Shed for punching, bending, riveting, etc.—the upper floor being used as a Mold Loft. Outside of the building, extending entirely around it on all four sides, is an overhang 12 feet wide, thus affording additional shop room outside of the building, where raw material may be stored and still be protected from the weather. Wide openings are placed every 40 feet so that raw material may be taken in, and finished product moved out, cheaply and quickly. The supporting frame is all iron throughout, and between the iron posts on the sides is a light brick wall.

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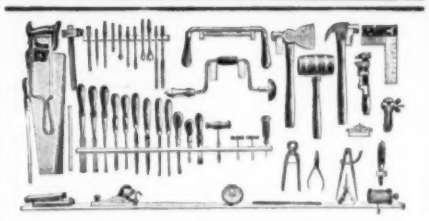

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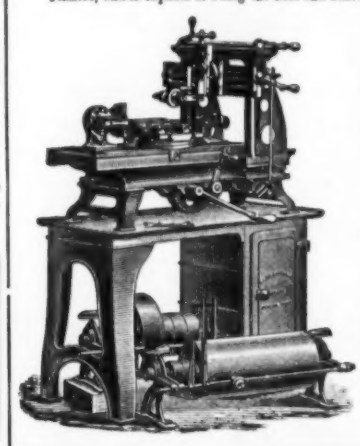

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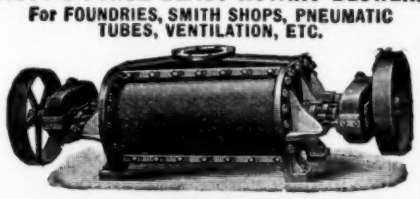

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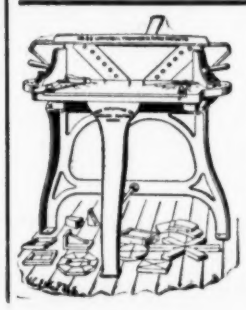

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Portable Drill.
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3 22 in. Back Geared.
2 25 in. " & P. F., Snyder.
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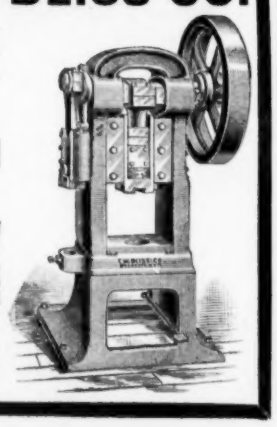

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18 x 10 Blaisdell, Plain Rest.
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16 in. x 16 in. x 4 ft. Hendey.
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10 in. Juengst, Crank.
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15 in. Juengst Friction Shaper.

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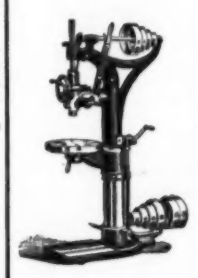

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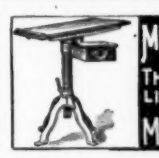

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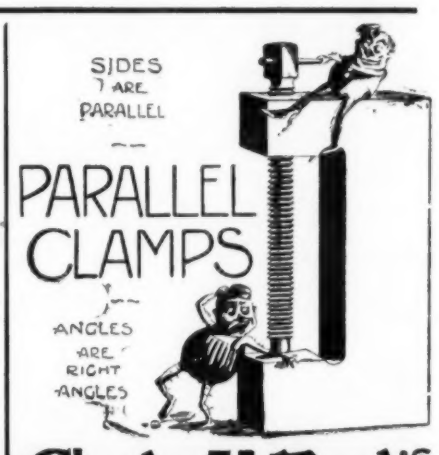

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40 in. Bement Vertical Drilling Machine.
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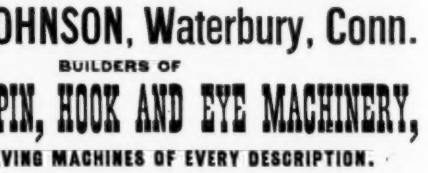

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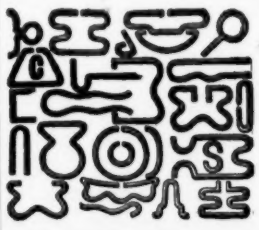

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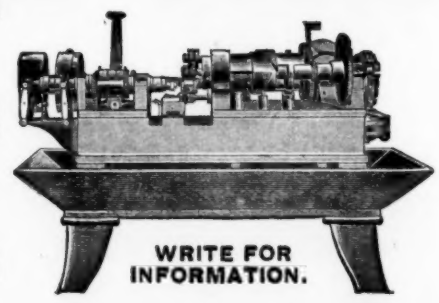

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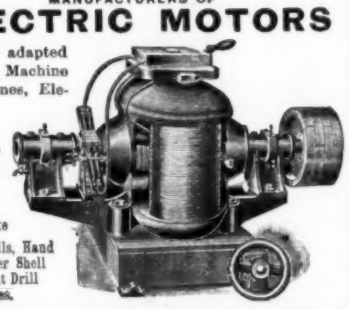

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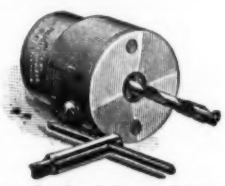

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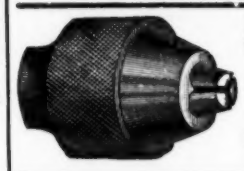

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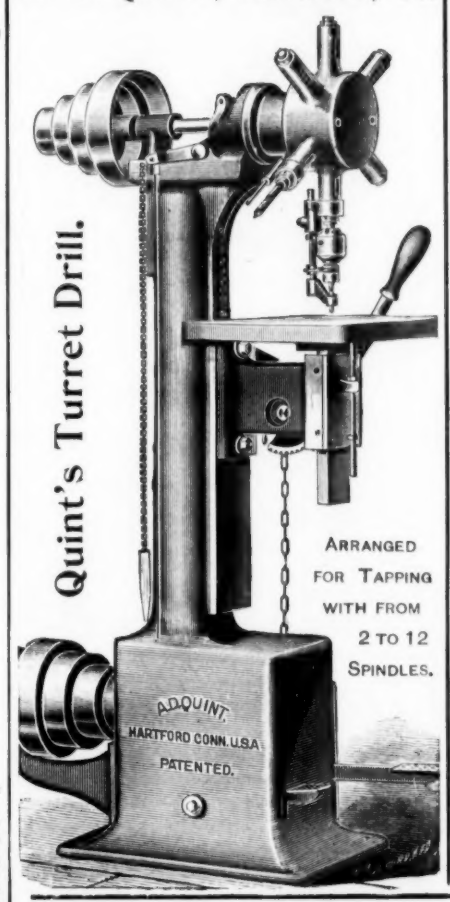

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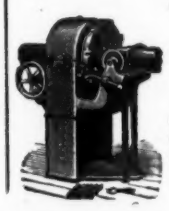

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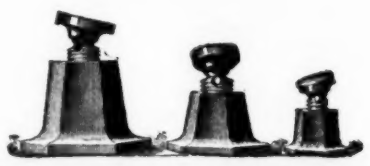

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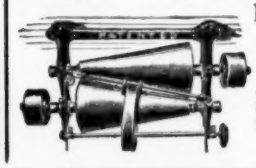

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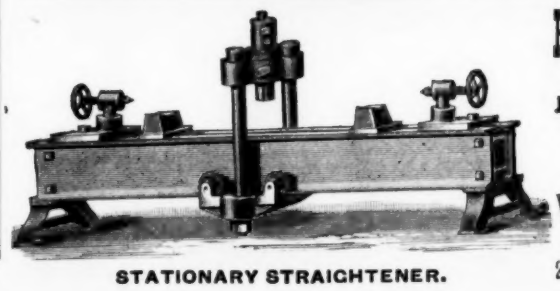

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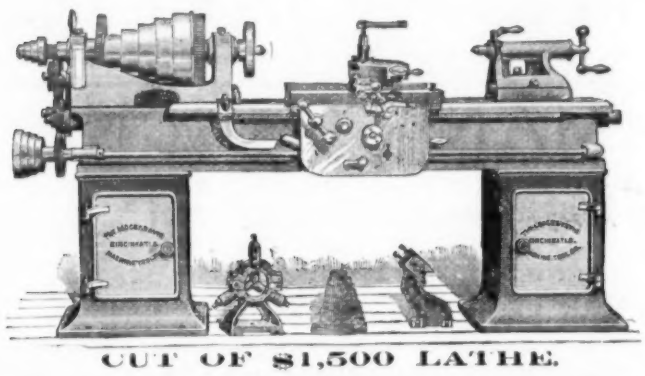

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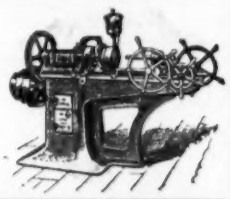

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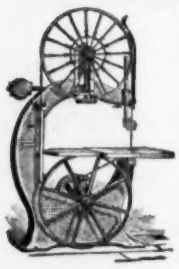

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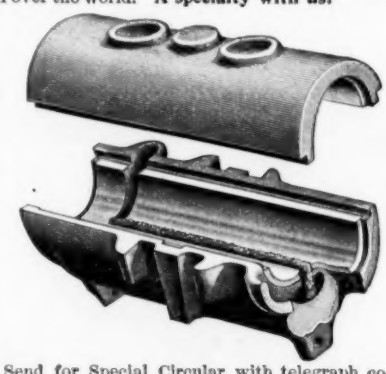

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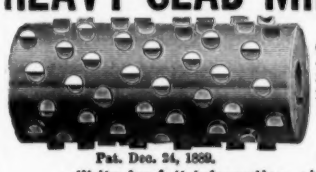

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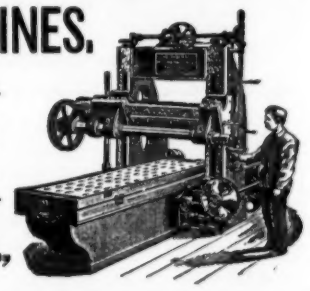

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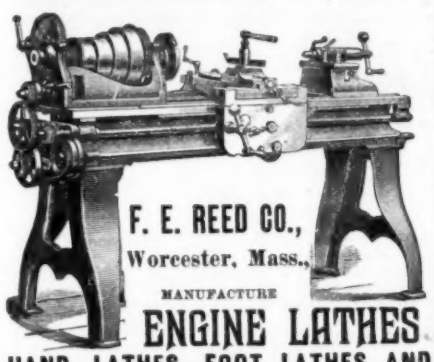

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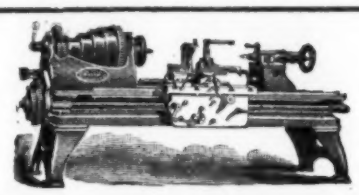

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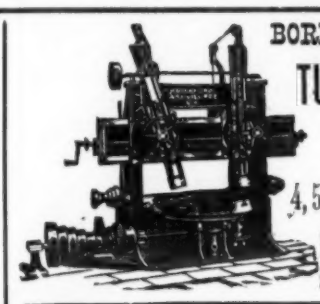

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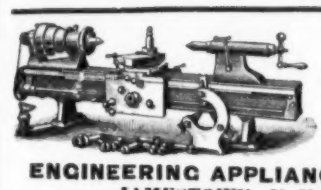

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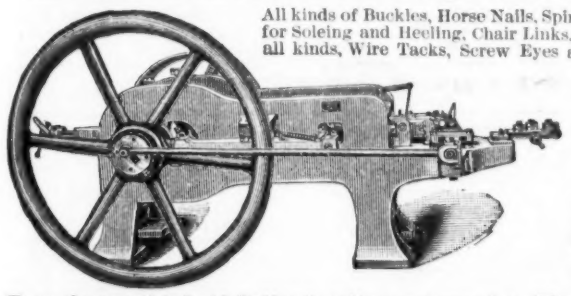
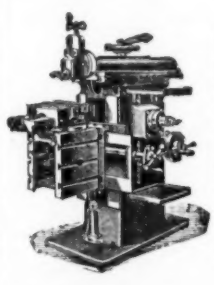


All kinds of Buckles, Horse Nails, Spiral Springs, Tin-opening Keys, Nails for Soleing and Heeling, Chair Links, Box and Coffin Handles, Rivets of all kinds, Wire Tacks, Screw Eyes and Screw Hooks, Cramps, Hinges, Lock and Piano Nails, Hob Nails of all kinds, Corset Buttons, Sliding Bolts, Eyes, Loops, Leaden Rivets, Leads, Spring Bands, Square Nails for Heeling; Wire Bending and Wire Cutting Machines, Shaping Machines, Machines for making Hooks and Eyes for Ladies' Dresses, Trowsers Hooks and Trowsers Eyes, as well as Hooks and Eyes for Military Cloaks; Tacks and Rivet Presses, etc.

We are also prepared to furnish Machines for making a great many other articles not mentioned above, on receipt of Samples.



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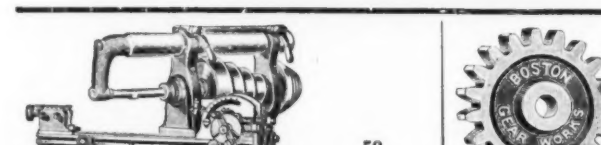

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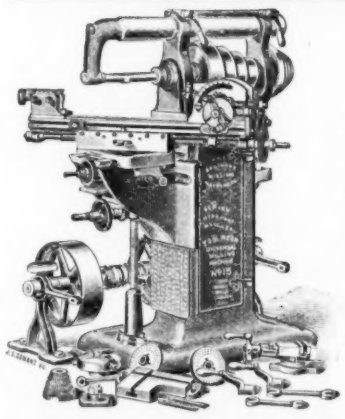

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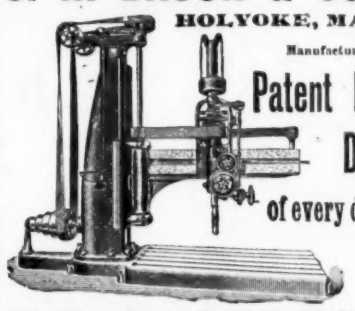

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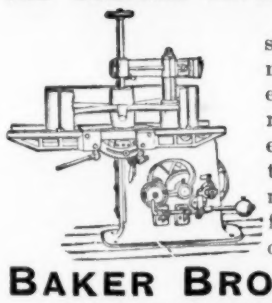

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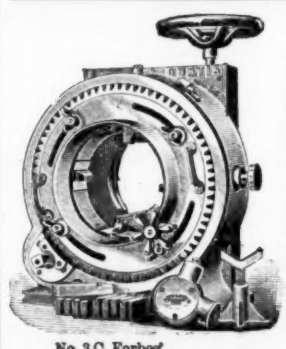

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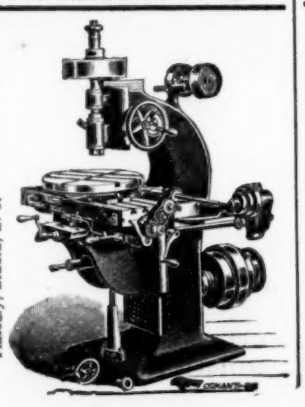

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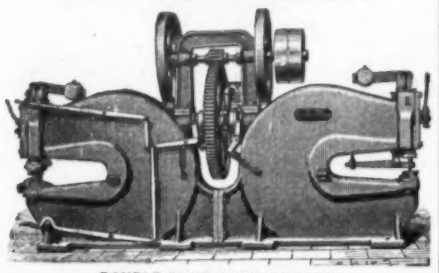

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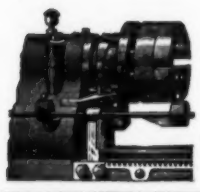

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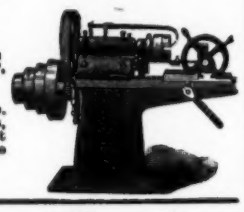

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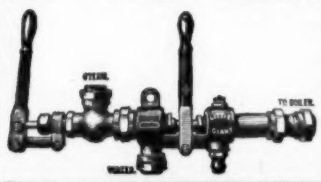

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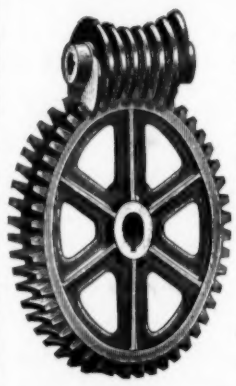

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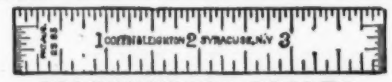

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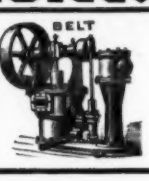

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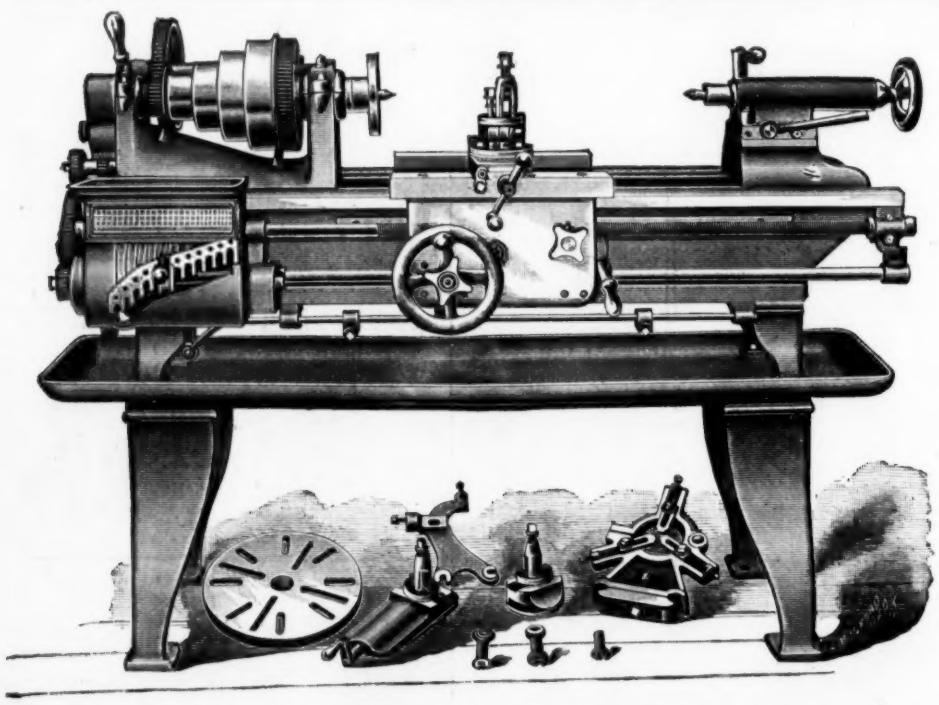

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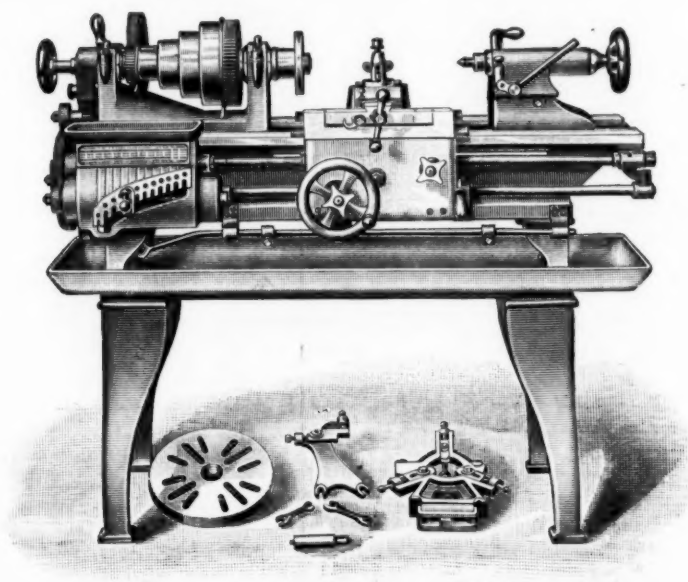

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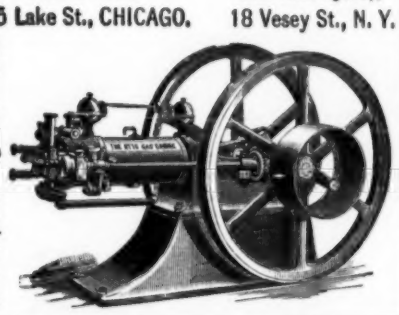

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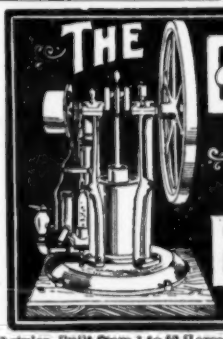

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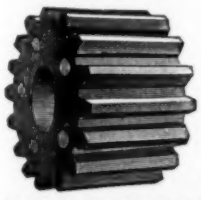

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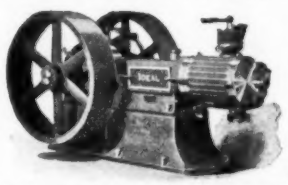

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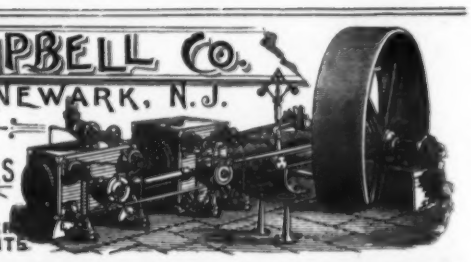

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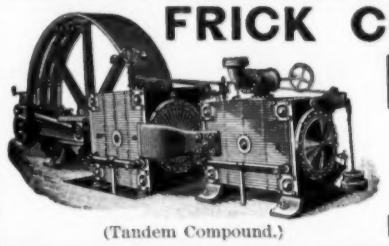

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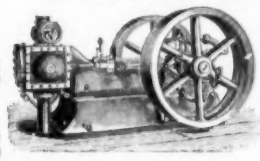

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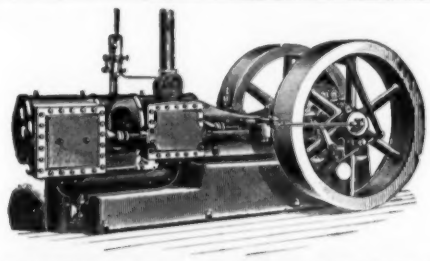

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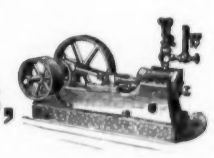

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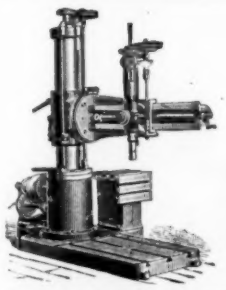

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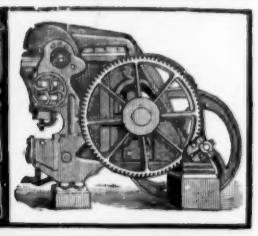

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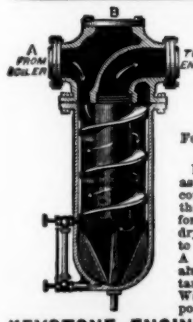

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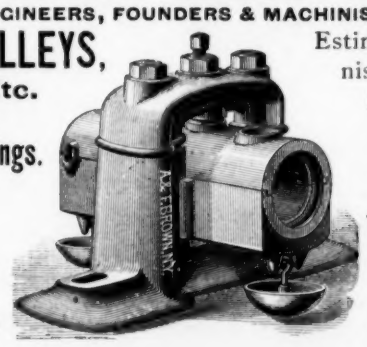

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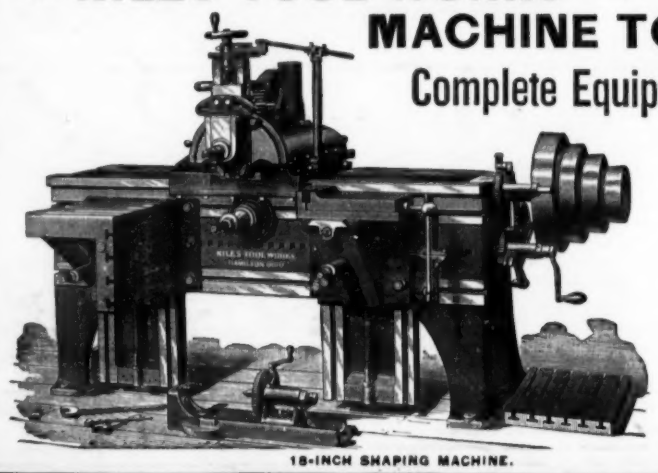

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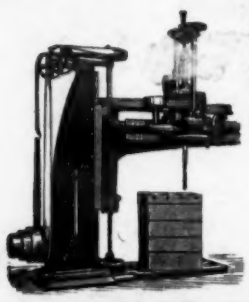

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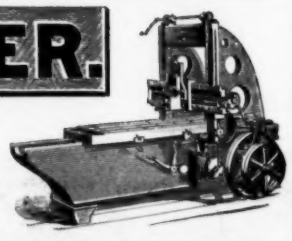

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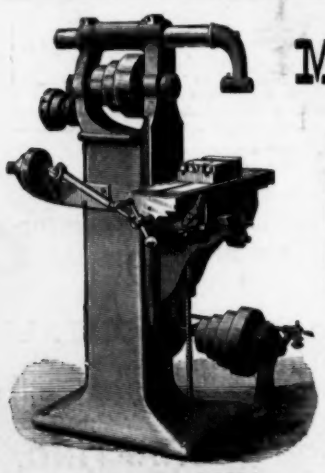

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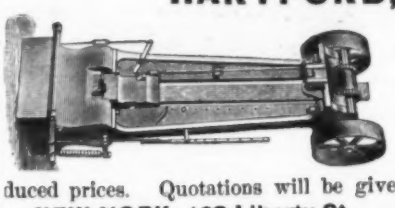

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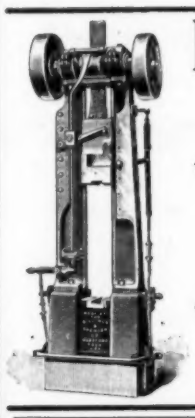

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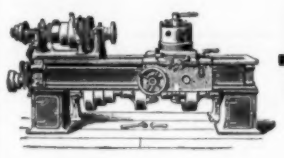

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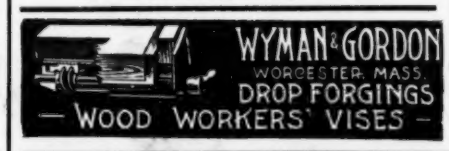

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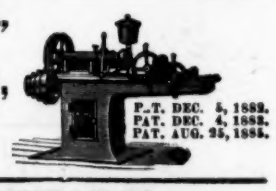

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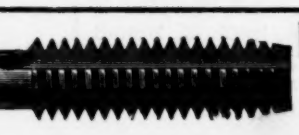

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